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LONG-SPAN BRIDGES.*

By Prof. W. H. BURR, of Columbia University.

I HAD intended that this paper should be prepared in a way commensurate to the importance of its subject, but, unfortunately—for me at least—the summer which I had counted on as the time during which I could make such preparation passed out of my control, so that I am not able to present the analytic part of the work as I had intended. I shall at least endeavor to set before the club some, perhaps crude, ideas relating to long span bridge design, in the hope that possibly some one may be inclined to take up those portions of the subject which I have not been able to prepare for this evening.

It is a very important subject for American bridge engineers at the present time, because we have, I think, come to that point in the engineering work of this country when bridges of unusual span must be constructed. We have two or three either already constructed or in process of construction. I refer, of course, to the old East River Bridge, known as the Brooklyn Bridge, and the new East River Bridge. Both of these structures have spans which are certainly unusual, although they have been exceeded by the span of the Forth Bridge.

In order to begin with the subject in a rational manner, it is necessary to consider some of the elementary features of ordinary bridge design. The prominent type of American bridge is, of course, the simple non-continuous span, which is represented in its most elementary form by the plate girder (Figs. 3 and 4). The functions of the flanges and web of the girders are identical with those of the chords and web-members of the ordinary simple non-continuous truss. In the solid plate of the plate girder the condition of the stresses is a matter open to some difference of opinion. In fact, the stresses probably travel in different paths, according to the presence or absence of stiffeners, but whatever may be the details of that stress condition, it is certain that we have stresses either more or less nearly vertical or inclined at various angles—that is, the metal of the web is so disposed, and must be so disposed, as to permit stresses to travel in a more or less zigzag manner between the flanges of the girder, precisely as in different types of web-members of trusses. Those web-members may be vertical or inclined, or all inclined, but the stresses travel in a more or less oblique direction from one chord to the other. In other words, there is considerable metal required between the flanges or chords to enable the shearing stresses to pass from one chord to another, and to give to those chords the stresses which exist in them. In these structures there is a large number of members with their various details of the joints, and they are so conditioned in reference to the moving load that the working stresses in them are comparatively low. In other words, those working stresses are comparatively small fractions of the ultimate resistance of the metal. That, perhaps, is something to which we are so accustomed in ordinary daily practice that we fail to give it much consideration. As a matter of fact, a working stress which is from one-fourth to one-fifth of the ultimate resistance is a low working stress. Again, the metal of such structures is what may be called of ordinary character. It is metal which has to be used in considerable masses and which must be produced at the lowest possible unit cost. In the ordinary, simple, non-continuous bridge it is sometimes difficult to design members which are massive enough—that is, if they are designed to meet the actual stresses which exist, their sections are too small for such stiffness and stability as is desired in a first-class bridge design.

Under these circumstances it is a matter, perhaps, of relatively little consequence in what shape the metal is used or in what manner the stresses travel—to use that expression for lack of a better one—from the points of application of loading to the points of support or the points of reaction. In existing long-span simple truss bridges, of which we have a considerable number of excellent examples in this country, in which the spans are from 500 to 550 or more feet in length (Fig. 5), there is shown, I think, excellent engineering skill in the disposition of the metal to meet the conditions under which it is used.

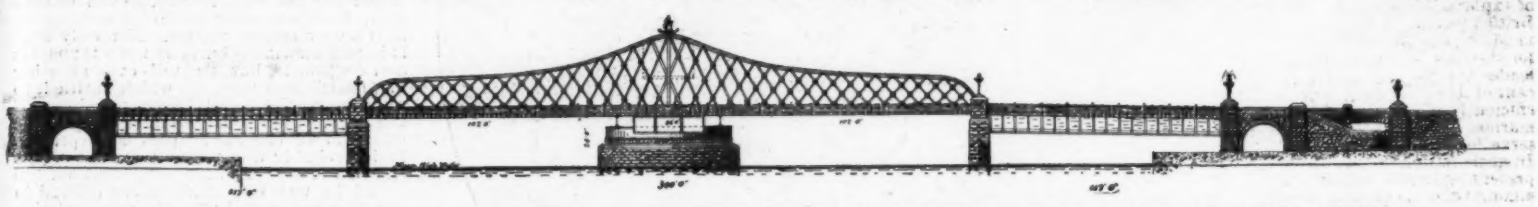


PLATE GIRDERS AND RIVETED MULTIPLE-INTERSECTION TRUSS—HARLEM RIVER DRAWBRIDGE AT THIRD AVENUE.

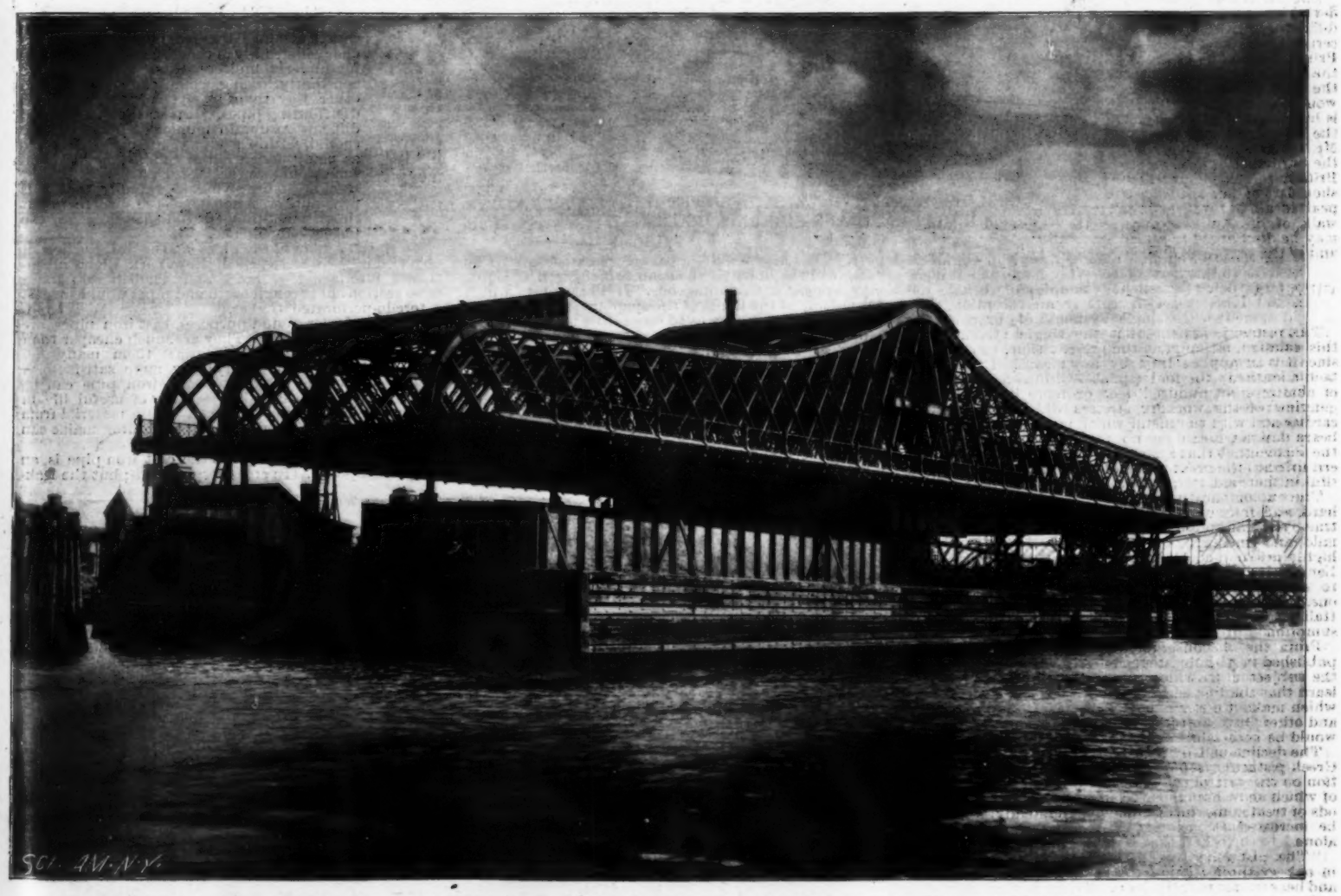


FIG. 1.—RIVETED, MULTIPLE-INTERSECTION TYPE—THIRD AVENUE DRAWSPAN ACROSS THE HARLEM RIVER, NEW YORK.

Length, 300 feet; breadth, 86 feet; weight, 2,500 tons.

* An address delivered November 4, 1899, before the Engineers' Club, of Philadelphia. Revised by the author for the SCIENTIFIC AMERICAN SUPPLEMENT. The illustrations herewith given are supplied by the SCIENTIFIC AMERICAN to replace the views used at the lecture.

There are various resources of design by which multiple systems of bracing are eliminated, resulting in relatively large sections of metal concentrated in a few members; and whatever may be said about the stiffness of multiple systems of bracing connected at intersections, I think that what may be called the massive design of few members in our long-span bridges is a very excellent feature. It is not my purpose to make any observation in this connection which even would appear to be a criticism of multiple systems of bracing with riveted joints (Figs. 1 and 2); but I think there is little difference of opinion among American engineers at least as to the best of the very long-span bridges now built being excellent examples of bridge design, and I believe, with scarcely an exception, they are designed with single systems of bracing. It is not my judgment that the single system long-span design, as found at the present time, has reached its limit of applicability by any means. I would not be surprised to find spans within a few years reaching eight hundred feet or more in length, but in view of the working stresses which it is feasible to use and with the metal which must be employed in such designs, I can see no reason at the present time to believe that that system of design can possibly be adapted to the great spans of from fifteen hundred to three thousand feet, which I believe may be attained within a comparatively short time. I am speaking, of course, from a point of view of such metal as we now have and can foresee in that part of the future which is within the reach of our observation.

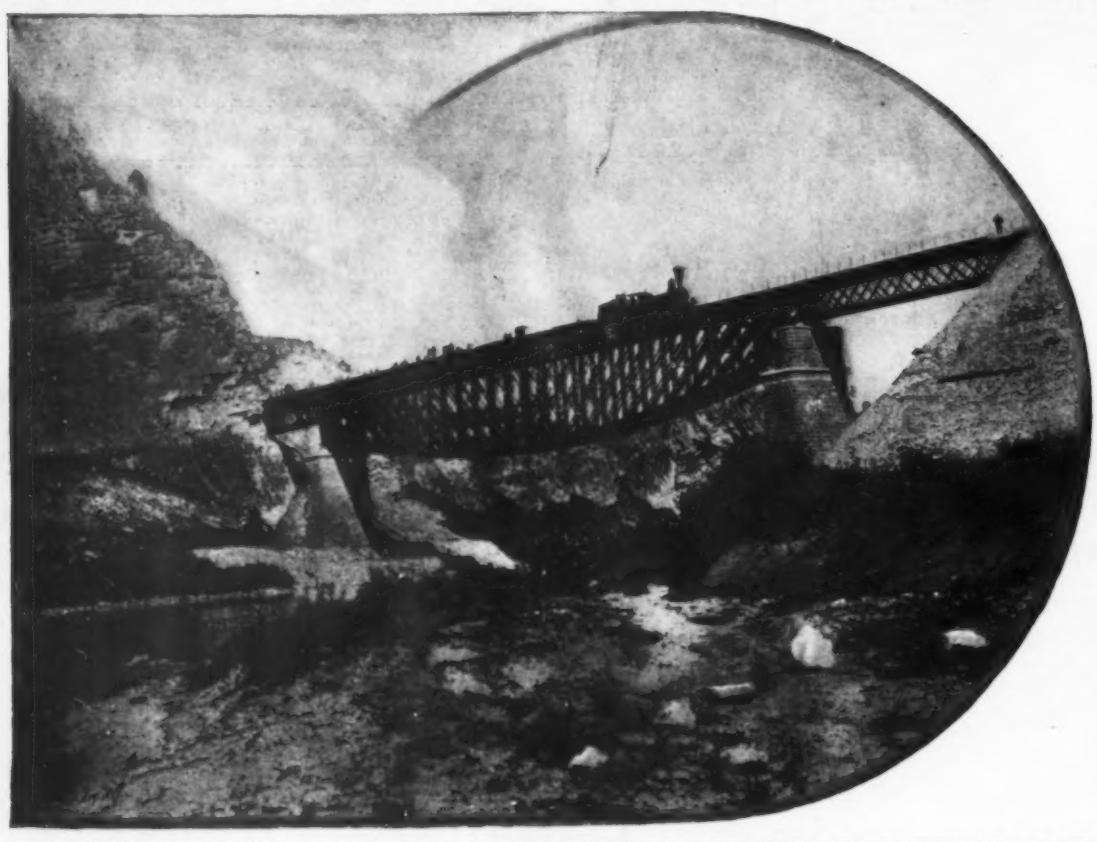


FIG. 2.—RIVETED, MULTIPLE-INTERSECTION TYPE—INVERTED BOWSTRING TRUSS BRIDGE ACROSS THE RIVER ZOURIAZAN, TRANS-SIBERIAN RAILROAD.

All these non-continuous spans or other ordinary truss-bridge designs are, so to speak, self-contained. Their reactions are vertical, and there is no part of the structure outside of the immediate limits of the span; but it is a question, and a very serious question, whether that is the proper type of bridge for the longest spans which must be constructed in the future. It has been customary in the past to consider the cantilever as a type of structure which is well adapted to great lengths of span, and, to a certain extent, that is true, but there is in the cantilever one serious defect. It is precisely that which we find in the simple non-continuous span, and to which I have already adverted. There is altogether too much path to be traversed by the stresses. The cantilever is, of course, nothing more or less than the ordinary bridge truss made continuous over the piers, and reaching back outside of the limits of the span to such distances as may be found advisable. We have the same chasing of stresses, so to speak, from one chord to the other, that is found in the ordinary truss bridge. In other words, the paths of stress from the points of application of the loading to the points of reaction are excessively long. There is that zigzaging across from one chord to the other and, consequently, the placing of metal along these lines which we have in the ordinary truss and which is fatal to economy in all long spans. In addition to that, the cantilever possesses other economic disadvantages. Its reactions are both upward and downward, and that condition, together with the corresponding truss continuity, brings excessively heavy shearing stresses on web-members. It is fairly well adapted, however, to the lower lengths of long span; and it is absolutely necessary if the truss form of construction is to be used where false works cannot be employed. The Forth Bridge is the most marked instance of cantilever construction that has been completed, although it is not a design which would ever be imitated; its proportions are very injudiciously taken, and there is failure to reach the degree of economy which ought to exist even in the cantilever.

In all the structures so far considered the compression member in the form of a long column plays a very important part. In fact, it predominates to such an extent that more than one-half of the weight of metal is found in that form. That in itself, at first sight, might not appear to be very serious; but, as a matter of fact, it is a very serious feature of design. It involves the material reduction of working stress which must go with every long column, and that necessitates a much increased section over a tension member carrying the same load. One of the first steps in the development of the long span bridge design must be such as will enable the metal to be used so as to give a high working stress, and very direct paths for the stresses from points of application of loading to the points of support. That may require a part of the structure to be outside of the limits of the span, which, at first sight, may appear disadvantageous. If those parts which are outside of the limits of the span are small, and can be made in such a way as to waste little material on details and be used with a high working stress, the economy will be very apparent, at least after a very little consideration. Obviously, the simple tension member, long enough to reach from one limit of the span to the other, is a very economic member in itself if it can be made to do the work of the structure.

It is obvious, also, that a compression member cannot be made to occupy such a condition simply because it does not tend to hold itself in position. It must be braced, if used in compression, precisely as in an ordinary truss. There are lengths of span under which compression members, as principal members, may be used to advantage; but I am now speaking of the longest long-span bridges. The type of structure which meets the fundamental requirements which have been set forth in this rather elementary and crude manner is the stiffened suspension bridge. That structure has as its principal carrying feature a simple tension member stretched from one limit of the span to the other in a vertical curve, and held at the tops of the towers by the backstays. The metal used in the cables may be such as to admit of the highest working stresses known to structural engineering practice. The ultimate resistance of wire suitable for cables is very high; certainly not less than 180,000 pounds per square inch at the present time, and it could probably be increased a third beyond that value with sensible increase of cost. The main members of the structure are exceedingly simple, and so placed as to carry the stress in almost the shortest possible path that can be conceived of.

(To be continued.)

CAUSES AND CORRECTION OF WATER AND GAS MAIN LEAKAGE.

POPULAR indifference to the leakage of underground pipes can only be explained by attributing it to popular ignorance of what this leakage really is and what it involves. When the facts are known, it will be seen that, from whatever viewpoint considered, it is a very serious matter. Not only does it impose enormous burdens upon taxpayers and consumers, but it entails evils affecting life, health, and property which entitle it to rank among the most important problems of the hour. That it has so long escaped the attention of the newspapers is surprising. It is probably due to the fact that all the exact information on the subject which has found its way into print is crystallized in the transactions of the scientific societies, where those in quest of news never look.

The mileage of pipes it has in use may be accepted as showing the standard of civilization attained by a community. The tendency is steadily in the direction of multiplying underground conduits. New wants are constantly arising which can be met in no other way than by systems of mains and distributing pipes. If it was less costly and difficult to obtain municipal franchises, we should, within a few years, have ten times as many underground conduits as now, and each would serve a useful purpose. As it is, they are multiplying so rapidly that it is becoming a serious question where to put those now deemed indispensable to the public convenience.

A plan of the pipes at the intersection of any two important streets of New York shows an intricate interlacing of large and small lines; and a cross section cut through earth and pipes would suggest a teredo-perforated timber.

For most underground purposes, cast iron pipes are the best now produced. They are much cheaper than wrought iron pipes, they outlast them many decades, and they are in every way more satisfactory. Under average conditions, a cast iron pipe can be counted on for nearly half a century of useful life in the ground. Nature has given us no material from which an acceptable substitute for cast iron mains can be made.

It is generally believed that the cast iron pipe is an ideal water main. In some respects it is; but the leak-

FIG. 3.—PLATE GIRDER CONSTRUCTION—NEW YORK CENTRAL VIADUCT, NEW YORK.

age of cast iron water mains is so great that the truth will be credited only when verified by unimpeachable testimony. The fact is that very few systems of water mains anywhere in the world deliver at the foundation walls of the buildings supplied anything like 50 per cent. of the water drawn from the sources of supply. In average water works practice, main leakage represents from two-thirds to three-quarters of all the water charged to consumption.

Mr. George T. Deacon, probably the most eminent living authority on water works leakage and its correction, in his address as president of the engineering section of the Sanitary Institute of Great Britain (1894) said:

"All town supplies of water are divided, as we now know, into two parts

"1. That part which reaches the water fittings and is actually made use of or wasted by the consumer.

FIG. 4.—PLATE GIRDER CONSTRUCTION—NEW YORK CENTRAL VIADUCT, NEW YORK.

"2. That part which leaks out from the pipes, joints and fittings, and may do evil, but cannot possibly benefit any one.

"Experience of a large number of water supplies in this country and abroad has satisfied me that, on the average, the second division, that is, water lost by leakage, is the larger of the two."

Mr. William Hope, C.E., of Liverpool, in a valuable paper on the waste of water in public supplies, contributed to the British Institution of Civil Engineers, says:

"Even now the majority of the water works undertakings of this country lose by leakage more than one-half the total quantity of water supplied from the source. The proportion is often higher, and rises in many instances to three-fourths or more; while in comparatively new countries, such as America, Australia, and New Zealand, the proportion so lost is still greater."

By locating and stopping the leaks of the mains and service pipes, the daily per capita consumption of water in a number of English cities has been cut down as shown in the following table:

	Gallons.		Gallons.
Of Bath.....	from 47·7	to	21
" Gloucester.....	" 22	"	15
" Lambeth.....	" 33	"	18·34
" Carlisle.....	" 42	"	18
" Leamington.....	" 24	"	16
" Oxford and Cambridge	" 80	"	18

Reams of similar testimony might be quoted on equally good authority. But notwithstanding the fact, established by undisputable evidence, that no city or town can consume or waste 30 gallons per head per day, or ever has since civilization began, the announcement that the limit of the available water supply of one of our American cities has been reached at 150 to 200 gallons per head per day, will create a panic and secure popular approval for large expenditures to purchase new sources, build reservoirs, and lay additional and larger mains.

Philadelphia, with a present daily supply of 222 gallons per head, is now preparing to greatly increase its supply to avert a "water famine." The fact that in one district of that city a daily consumption of 523 gallons per head is recorded and the still more significant fact that the total day consumption of the city only exceeds the night consumption by about 20 per cent., do not seem to have suggested the obvious conclusion that, for every gallon used, four or five gallons are lost by leakage.

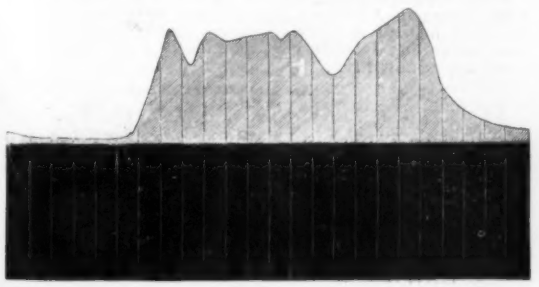
Sir Frederick Bramwell presented to the British Institution of Civil Engineers, in 1894, a diagram showing the relation of main leakage to measured use (including all house waste) in metered British cities and towns. We give the diagram below.

In the black parallelogram we have the constant leakage through twenty-four hours, from midnight to midnight. In the irregular shaded figure, above the parallelogram, we have the use of water, including house consumption and water drawn for street sprinkling, sewer flushing, fountains, and other public purposes. This shows the use to bear to leakage the relation of about 1 to 2; or, in other words, that of each unit of quantity of water admitted to the mains, 33⅓ per cent. is accounted for, and 66⅔ per cent. is unaccounted for. What becomes of the water unaccounted for, we have seen.

Equally exact data respecting American water works would show a relatively larger leakage and a relatively smaller consumption.

The late Col. George E. Waring, writing in 1897, summarizes the experience with public water supplies in this country in the following forcible words:

"The distribution system of every large water works is a sieve. Water is poured in at the source and dribbled away at a thousand points. Water works are not constructed for the sub-surface irrigation of the sites of towns, but that is their general and increasing function. Whatever else may happen, the underground leakage may be depended on 24 hours in the day and



RELATION OF USE TO LEAKAGE IN WATER DISTRIBUTION.

365 days in the year. It may also be depended on to increase as time goes on and the demand for water grows. Underground leaks rarely close up with use; they grow larger rather than smaller; and if more head is put on at the beginning of the pipage, to get more pressure at remote points, every leak will be made to run faster in consequence."

That conditions warranting such statements can exist will be difficult of credence unless it is remembered that under pressure a great deal of water will escape from a very small leak. This was briefly and clearly shown in a report on the water supply of Orange, N. J. (April, 1899), from which we quote as follows:

"The escape of water from a given leak, under different pressures, varies about as the square roots of the pressures compared. This is theoretical. In practice, increasing the pressure not only increases the leakage of existing orifices, but confuses calculation by providing the water with additional and more ample avenue of escape. In other words, what is a small leak under a given pressure per square inch, not only leaks more but becomes a larger leak under increased pressure. The rule for calculating leakage under given or assumed heads is very simple, if one has a basis to work from. We have seen that an opening in a main having an

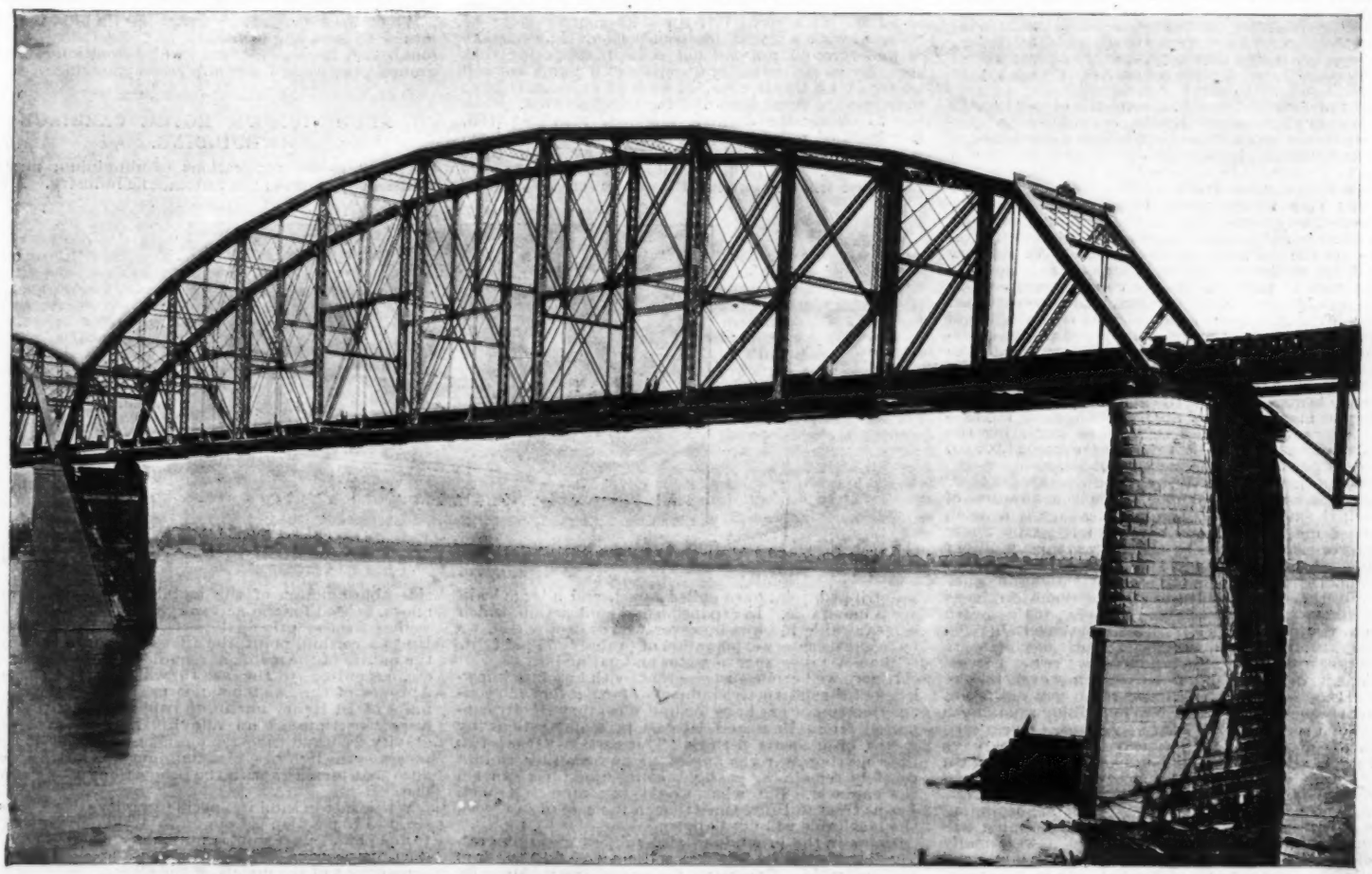


FIG. 5.—LONG-SPAN, NON-CONTINUOUS, AMERICAN, PIN-CONNECTED TRUSS—THE MERCHANTS' BRIDGE, ST. LOUIS.

Three spans, 517 feet 6 inches, and six spans, 125 feet long.

area equal to that of a round hole ¼ inch in diameter, under a head of 45 pounds, will leak 540 gallons per hour, or 12,900 gallons per day. What would it leak under a head of 60 pounds or 90 pounds? The equation would read: $540 : x :: \sqrt{45} : \sqrt{60}$ (or $\sqrt{90}$). If you will take the trouble to work this out, you will find that with 60 pounds head $x = 601{\cdot}3$ gallons per hour, or 14,431 gallons in 24 hours; and at 90 pounds head $x = 775$ gallons per hour, or 18,600 gallons in 24 hours. This is assuming that, under increased pressure, the leak would not increase in area—which it probably would."

Almost from the beginning of his industry, the gas engineer has followed hydraulic practice. If he has lost a less percentage of what he has undertaken to distribute than his professional brother of the water works, it is only because gas is piped under very low pressures.

Gas main leakages as high as 60 per cent. of the product of the retorts are recorded, but anything above 45 per cent. is exceptional. The average gas leakage is about 20 per cent.

In the case of gas, however, percentages are misleading as a basis for comparison between plants. A much fairer and more intelligible basis is offered in the leakage per unit of main length in a given time.

From this standpoint, ten well built and presumably well managed American gas plants, designated by numbers instead of their corporate names, made for the year ending June 30, 1898, the following showing of "gas unaccounted for:"

	Average Diameter of Mains. Inches	Leakage per Mile of Main. Cubic Feet.
1	2·51	202,006
2	4·98	202,278
3	5·33	210,062
4	4·46	258,385
5	3·34	268,129
6	4·49	272,350
7	7·43	292,012
8	4·52	360,699
9	4·46	364,195
10	3·96	409,886

The chief interest of the above table consists in the fact that the data at command permits the leakage to be stated in relation to the average diameter of mains. The normal rate of gas main leakage varies directly as the diameters. When, therefore, a leakage of over 400,000 cubic feet per mile per annum is recorded for mains of less than 4 inches, we can easily calculate the actual average leakage of the 6-inch or 13-inch mains.

That such leakages are not peculiar to American gas practice is shown by the following statistics compiled from the official returns of British companies for the calendar year 1898.

The seven gas companies supplying London and its suburbs, had in use 3,208 miles of mains. Their total leakage loss was 1,714,399,000 cubic feet, or an average of 534,414 cubic feet per mile of main. The largest leakages per mile of main were:

	Cubic Feet.
London G. L.	554,509
Commercial	639,867
South Metropolitan	460,910
Crystal Palace	491,134

Some of the gas companies in other British cities make the following showing:

	Total Gas Lost. Cubic Feet.	Per Mile of Main. Cubic Feet.
Richmond	13,226,000	413,333
Wandsworth	38,890,000	544,225
Birmingham	329,312,000	554,317
Leicester	60,275,000	334,868
Nottingham	108,916,000	368,113
Salford	123,010,000	530,211
Newcastle-on-Tyne	182,743,000	594,909
Glasgow	555,066,000	1,642,207

Very few accurate or official statistics of gas leakage in American cities, except Boston, are obtainable. Expert testimony given under oath before a committee of the Pennsylvania legislature stated the leakage of mains in Philadelphia to have been 871,000 cubic feet per mile in 1894, and 835,000 in 1895. What the leakage is in New York is a well guarded secret. That it is very large—probably larger than in London, and possibly even as large as Glasgow—is generally conceded. Nowhere are the gas mains so much disturbed as in New York by an endless succession of street excavations for one purpose or another. As the conditions of success in the gas business change, leakage increases. Most, if not all, the New York companies, as well as those of other large cities, now report a day consumption greater than the night consumption. This is due to the immense volume of gas consumed for cooking and heating, and in manufacturing operations requiring moderate heats. To meet the increased draught upon the mains, many of which are too small, some increase of delivery pressure is necessary, thus increasing the leakage. That in places it a good deal exceeds 1,000,000 cubic feet per mile is extremely probable.

It will naturally occur to the thoughtful reader that, whereas water main leakage is chiefly a question of municipal extravagance, gas main leakage is a much more serious matter, especially when it occurs under asphalt or other practically gastight pavements. What becomes of the gas thus lost? Some of it is held in the superficial earth strata and creates the familiar nuisance in connection with street excavations. Some of it leaks into subways and sewers, and is occasionally heard from in explosions which hurl manhole covers high in air and rip up sections of streets. Such accidents are briefly recorded in the newspapers as "sewer gas explosions." Most of the gas leakage, however, follows along the mains and works its way into coal vaults and cellars through the soft and pervious filling around gas and water service pipes. This constitutes a very serious menace to life and property, of which we have had many unrecognized and unheeded warnings. On the morning of September 28, this year, a decorator in the basement of No. 151 East Fifty-sixth Street, New York, struck a match to light his pipe before beginning work. Instantly the whole front of the building was blown out, and those on either side of it were badly wrecked. The decorator, who was alone in the house, was killed. The cause was a leaky gas main in the street. Last spring, two costly fires occurring almost simultaneously—one attended with a distressing loss of life and the other fortunately without fatality because the house was unoccupied—gave the danger signal. Both were due to gas leakage under impervious street pavements.

Well built dwellings of the best class do not flash into flame by reason of their structural combustibility. Not long after a prominent hotel—not fireproof, but well built according to the standards of its time and very well managed—was consumed with inexplicable suddenness. The loss of life was appaling. Nothing in the construction or furnishing of this building carried the fire from basement to roof like a flash along a powder train. It was undoubtedly a gas fire. Those most interested have been surprisingly successful in concealing the disquieting facts from the public notice; but the truth is slowly dawning upon the fire underwriters that the cause of many mysterious and costly fires may be looked for in this direction. With gas main leakage creating incendiary conditions wherever opportunity offers, and water main leakage wasting head and reducing volume until not enough water remains for fire department purposes, the outlook is becoming serious from the underwriters' standpoint.

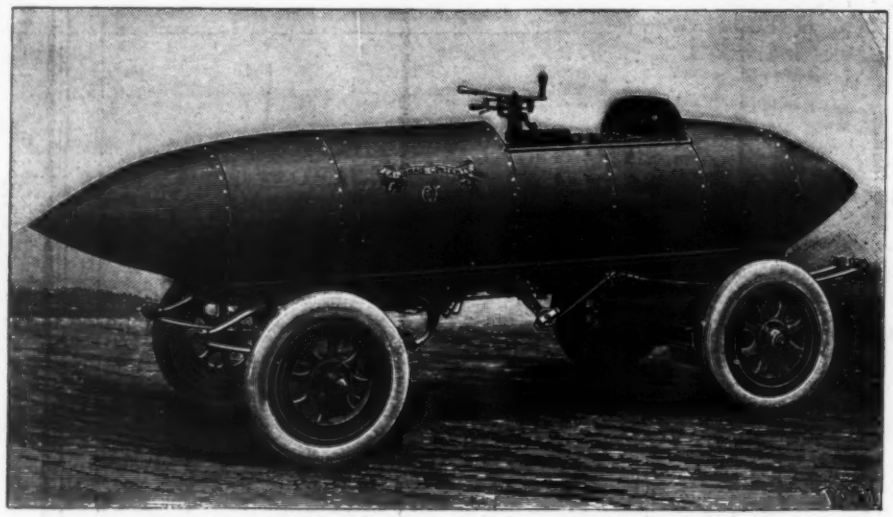


FIG. 1.—THE JENATZY CARRIAGE, WITH PARTINIUM BODY.

At the meeting of the Western Gas Association in Cincinnati (May, 1897) the question of how to discover and locate gas leaks under asphalt was raised, and discussed, but not answered. It never has been answered. This may suggest the question: Can we afford to put down impervious pavements until we learn how to minimize main leakage?

For the causes which induce leakage in underground mains, the engineer is in no sense responsible. They are irresistible natural forces. Of these expansion and contraction are the most potent. Mains are never at rest in the ground. A difference of one degree in temperature will set them moving ("crawling" some engineers call it), and the total movement due to the range of summer and winter temperatures, if not much in inches per mile, is exerted with such power that the strongest material at the command of the engineer could no more resist it than a locomotive could be tethered with a thread of spool cotton. The mistake in underground practice has been in supposing that these forces can be safely disregarded if joints are well made. With this in view, all sorts of expedients have been tried to strengthen and rigidify pipe lines. Failing to obtain the desired standards with cast iron, hundreds of miles of wrought iron pipes have been used for gas distribution, connected by steam tight screw joints. The results of all such experiments have been just what might have been expected. Threads are stripped, joints are pulled apart, and a large leakage is inevitable. In expansion and contraction, which is measurable in pipes however well or deeply laid, we have a satisfactory explanation of probably 75 per cent. of the normal leakage of water and gas mains.

It may well excite surprise that, with absolute knowledge of the destructive influence of expansion and contraction, engineers have for half a century rigidly connected trunk lines and laterals in main systems by means of inelastic fittings. The certainty that two lines moving at right angles to one another cannot possibly remain in gastight connection, has worried the engineer. But what would you have? Kismet. Let us trust to Providence that in the case of our work the inevitable will not happen.

Mains in the ground are also subject to disintegrating disturbance by unequal settlement and the jar of surface traffic. Excavation under and around them increases leakage. It is the habit of the contractor to fill back without concentrating until near the surface level, and then pound solidly to get the pavement in place, with the result that the subsequent settlement must carry the unsupported pipes with it. All the disturbing influences affecting the integrity of mains, except electrolysis and natural corrosion, admit of one general classification, and what neutralizes one cause of leakage will neutralize all. That the point of an absolutely leakless distribution of water or gas in buried pipes will ever be attained, is improbable. Leakage can, however, be minimized and kept at a minimum, either by constant vigilance and large expense, as in the case of the Liverpool water mains, or by the use of mechanical means which will accommodate natural movement. The solution of this great problem of the distribution of fluids and gases with a negligible leakage per unit of main length, must be sought in exactly the opposite direction from that in which the experimentation of half a century has tended. The first gas mains used were probably the strongest and most rigid ever made. They were of heavy iron, cast with stout flanges on the ends, and were joined by bolting together on gaskets of sole leather. They broke like pipe stems, and had they been stronger and more rigid they would have gone into a greater number of pieces. This should have made its lesson plain, but education in the school of experience is slowly acquired. We have not yet learned to apply in our household economies the elementary truths demonstrated by the greatest of American scientists, Benjamin Thompson (Count Rumford), nearly a century and a half ago.

What our water and gas engineers have yet to learn may be stated in the following brief propositions:

1. That in underground mains rigidity is fatal to tightness and durability.

2. That natural forces are irresistible, and if not accommodated will accommodate themselves.

3. That the first cost of mains per unit of length is of vastly less consequence than freedom from leakage and repairs.

When these elementary truths are familiarized, the means of securing elasticity and flexibility will be found, and its demonstration will revolutionize underground practice in water and gas engineering.

ALUMINIUM IN MOTOR CARRIAGE BUILDING.

AMONG recent applications of aluminium may be mentioned its use in the automobile industry. A con-

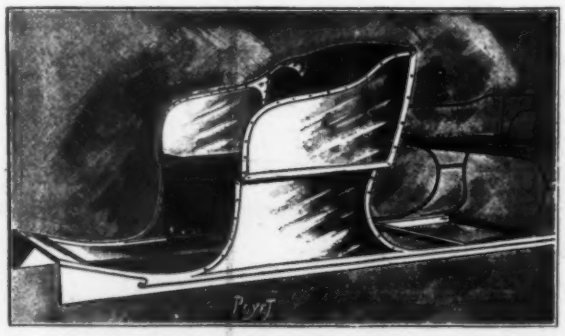


FIG. 2.—PARTINIUM BODY FOR AN AUTOMOBILE.

siderable amount of the metal, and especially of its alloys, is used for the accessory pieces of the frames as well as for the principal parts of the carriage work. Up to a certain point, the alloys permit of modifying the nature of the metal, as regards resistance, cohesion, etc., according to the use to which it is to be put. Apropos of this, we must not neglect to mention the name of M. Henry Partin, to whom French industry owes "partinium," an alloy of aluminium (specific gravity 2·56) and tungsten (specific gravity 19·10) which possesses the lightness of aluminium along with a resistance that increases with the proportions of the alloyed metal.

When cast in sand its specific gravity is 2·89. Its resistance to traction is from 12 to 17 kilogrammes (26·4 to 37·4 pounds) per square millimeter (0·039 inch). Its ductility is from 12 to 6 per cent, according to the proportions of the metals of the alloy.

When rolled, its density is 3·09. Its resistance to traction is from 32 to 37 kilogrammes (70·4 to 81·4

pounds) per square millimeter (0·039 inch); and its ductility is from 8 to 6 per cent.

Cast partinium is employed for making the cases for inclosing the motors of tricycles, and also for making the enormous cases used in the De Dion steam carriages of from 30 to 50 horse power. For all such uses, bronze and copper have, without any inconvenience, been replaced by a metal which weighs one-half less and has a resistance a third greater. It should also be added that for this work the net cost of the raw material is the same, whether it be bronze or partinium, and that the net cost of the finished piece is less in the case of partinium, which is more easily worked.

Finally, the rolled metal has been employed for over a year in the manufacture of the bodies of automobiles. It can be bent into any shape, and is capable of being decorated with metallic mouldings. A body of this kind mounted upon an angle iron frame, with a sheet iron facing, possesses as a whole, with equal resistance, a weight from 50 to 60 per cent. less than wood, and may, if certain precautions be used, receive the same coats of paint as are employed in fancy carriage-work. Here again the industry has made big strides.

The first partinium body dates back to the Paris-Bordeaux race of 1898. At present this important improvement in carriage work has been adopted by racers, because weight plays an important part in the result of a contest, and by tourists because they think that it is better to replace one or two hundred kilogrammes of dead weight by passengers and useful baggage.

Finally, as a sequel to some experiments on crushing, which showed that this metal can be submitted to a pressure of 38·2 kilogrammes (84·04 pounds) to the square millimeter (0·039 inch) without distortion, there has recently been begun the manufacture of houses which may be taken apart and carried to any point.

It will be seen that aluminium is becoming more and more practical in all its forms. It will become still more so when the cost of it, which is already reasonable, will permit of using it in new industrial applications. For the above particulars and the illustrations, we are indebted to La Nature.

A CONVENIENT DARK ROOM.

By JOHN A. FOOTE, Archibald, Pa.

MANY druggists, particularly those doing business in the smaller towns and cities, have found it profitable to sell photographic supplies and cameras. In most cases the druggist is an amateur photographer himself; sometimes he does developing and printing for amateurs, and sometimes he is wise enough to offer the use of a dark room free to his patrons.

This latter course will surely attract business if it is properly arranged. The room does not need to be elaborately furnished, or to contain any wonderful improvements, to accomplish its end. I submit sketches of a dark room that I have had constructed in my store, and I think that it contains some points that may be found useful by other druggists.

The room was built of matched pine, in a corner of the store, and was about four feet square. It was about six feet high, and the top was boarded over closely, with moulding around the floor and ceiling joints to prevent the entrance of light. All suspicious orifices were puttied, and a coat of black paint was applied to the interior.

Most amateur dark rooms are lighted by the nasty smelling "ruby lamps," that not only vitiate the air, but add a wholly unnecessary warmth to the already oppressive air of the closet. In my room the ordinary kerosene lamp or an electric light may be used. Outside of the window, *F*, which is of ruby glass, is a shelf on which a lamp may be set. Or an electric light may be hung in front of the window, and lighted when needed, thus leaving the source of the light outside the room entirely.

The shelf, *B*, and the shelf, *C*, form a box with the sides of the room, and the slide, *A*, forms the side of the box parallel with the wall, when it is closed in position (Fig. 1). Pushing it upward and fastening it in place with an ordinary sash catch leaves the working bench displayed as in Fig. 2. A galvanized iron can, with a stop-cock in its base, such as is generally used for dispensing oils, will furnish a convenient water supply, while a large glass funnel directly underneath, connected by tubing with a water pail, will furnish drainage.

A Device to Prevent Fogging.—The sliding cover, *A*, is used so that when the operator finds it necessary to leave the dark room during the progress of a development—a not infrequent occurrence—he can, by using this slide, make a light-proof box, in which the plate may be placed, and thus avoid the fogging that would otherwise surely be produced by the opening of the dark room door.—American Druggist and Pharmaceutical Record.

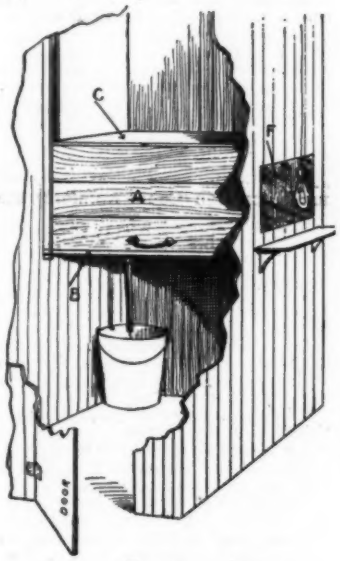


FIG. 1.

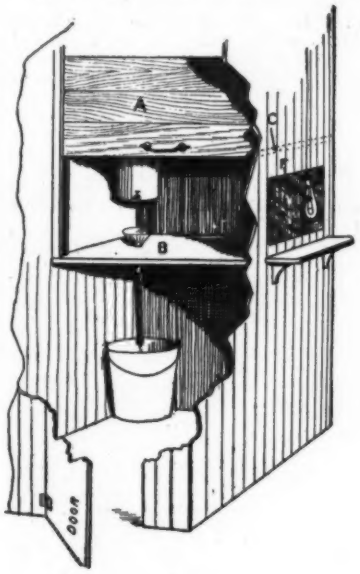


FIG. 2.

HOME-MADE DARK ROOM.

THE HIGHEST AIM OF THE PHYSICIST.*

By HENRY A. ROWLAND.

GENTLEMEN AND FELLOW PHYSICISTS OF AMERICA: We meet to-day on an occasion which marks an epoch in the history of physics in America; may the future show that it also marks an epoch in the history of the science which this society is organized to cultivate! For we meet here in the interest of a science above all sciences, which deals with the foundation of the Universe, with the constitution of matter from which everything in the Universe is made and with the ether of space, by which alone the various portions of matter forming the Universe affect each other even at such distances as we may never expect to traverse, whatever the progress of our science in the future.

We, who have devoted our lives to the solution of problems connected with physics, now meet together to help each other and to forward the interests of the subject which we love—a subject which appeals most strongly to the better instincts of our nature and the problems of which tax our minds to the limit of their capacity and suggest the grandest and noblest ideas of which they are capable.

In a country where the doctrine of the equal rights of man has been distorted to mean the equality of man in other respects, we form a small and unique body of men, a new variety of the human race as one of our greatest scientists calls it, whose views of what constitutes the greatest achievement in life are very different from those around us. In this respect we form an aristocracy, not of wealth, not of pedigree, but of intellect and of ideals, holding him in the highest respect who adds the most to our knowledge or who strives after it as the highest good.

Thus we meet together for mutual sympathy and the interchange of knowledge, and may we do so ever with appreciation of the benefits to ourselves and possibly to our science. Above all, let us cultivate the idea of the dignity of our pursuit, so that this feeling may sustain us in the midst of a world which gives its highest praise, not to the investigation in the pure ethereal physics which our society is formed to cultivate, but to the one who uses it for satisfying the physical rather than the intellectual needs of mankind. He who makes two blades of grass grow where one grew before is the benefactor of mankind; but he who obscurely worked to find the laws of such growth is the intellectual superior as well as the greater benefactor of the two.

How stands our country, then, in this respect? My answer must still be now as it was fifteen years ago, that much of the intellect of the country is still wasted in the pursuit of so-called practical science, which ministers to our physical needs, and but little thought and money are given to the grander portion of the subject, which appeals to our intellect alone. But your presence here gives evidence that such a condition is not to last forever.

Even in the past we have a few names whom scientists throughout the world delight to honor. Franklin, who almost revolutionized the science of electricity by a few simple but profound experiments. Count Rumford, whose experiments almost demonstrated the nature of heat. Henry, who might have done much for the progress of physics had he published more fully the results of his investigations. Mayer, whose simple and ingenious experiments have been a source of pleasure and profit to many. This is the meager list of those whom death allows me to speak of and who have earned mention here by doing something for the progress of our science. And yet the record has been searched for more than a hundred years. How different had I started to record those who have made useful and beneficial inventions!

But I know, when I look in the faces of those before me, where the eager intellect and high purpose sit enthroned on bodies possessing the vigor and strength of youth, that the writer of a hundred years hence can no longer throw such a reproach upon our country. Nor can we blame those who have gone before us. The progress of every science shows us the condition of its growth. Very few persons, if isolated in a semi-civilized land, have either the desire or the opportunity of pursuing the higher branches of science. Even if they should be able to do so, their influence on their science depends upon what they publish and make known to the world. A hermit philosopher we can imagine might make many useful discoveries. Yet, if he keeps them to himself, he can never claim to have benefited the world in any degree. His unpublished results are his private gain, but the world is no better off until he has made them known in language strong enough to call attention to them and to convince the world of their truth. Thus, to encourage the growth of any science, the best thing we can do is to meet together in its interest, to discuss its problems, to criticise each other's work, and, best of all, to provide means by which the better portion of it may be made known to the world. Furthermore, let us encourage discrimination in our thoughts and work. Let us recognize the eras when great thoughts have been introduced into our subject and let us honor the great men who introduced and proved them correct. Let us forever reject such foolish ideas as the equality of mankind and carefully give the greater credit to the greater man. So, in choosing the subjects for our investigation, let us, if possible, work upon those subjects which will finally give us an advanced knowledge of some great subject. I am aware that we cannot always do this: our ideas will often flow in side channels; but, with the great problems of the Universe before us, we may sometimes be able to do our share toward the greater end.

What is matter; what is gravitation; what is ether and the radiation through it; what is electricity and magnetism; how are these connected together, and what is their relation to heat? These are the greater problems of the universe. But many infinitely smaller problems we must attack and solve before we can even guess at the solution of the greater ones.

In our attitude toward these greater problems, how do we stand and what is the foundation of our knowledge?

Newton and the great array of astronomers who have succeeded him have proved that, within planetary distances, matter attracts all others with a force varying inversely as the square of the distance. But what sort of proof have we of this law? It is derived from astronomical observations on the planetary orbits. It agrees very well within these immense spaces; but where is the evidence that the law holds for smaller distances? We measure the lunar distance and the size of the earth and compare the force at that distance with the force of gravitation on the earth's surface. But to do this we must compare the matter in the earth with that in the sun. This we can only do by assuming the law to be proved. Again, in descending from the earth's gravitation to that of two small bodies, as in the Cavendish experiment, we assume the law to hold, and deduce the mass of the earth in terms of our unit of mass. Hence, when we say that the mass of the earth is 5½ times that of an equal volume of water, we assume the law of gravitation to be that of Newton. Thus a proof of the law from planetary down to terrestrial distances is physically impossible.

Again, that portion of the law which says that gravitational attraction is proportional to the quantity of matter, which is the same as saying that the attraction of one body by another is not affected by the presence of a third, the feeble proof that we give by weighing bodies in a balance in different positions with respect to each other, cannot be accepted on a larger scale. When we can tear the sun into two portions and prove that either of the halves attracts half as much as the whole, then we shall have a proof worth mentioning.

Then as to the relation of gravitation and time, what can we say? Can we for a moment suppose that two bodies moving through space with great velocities have their gravitation unaltered? I think not. Neither can we accept Laplace's proof that the force of gravitation acts instantaneously through space, for we can readily imagine some compensating features unthought of by Laplace.

How little we know then of this law, which has been under observation for two hundred years!

Then as to matter itself, how have our views changed and how are they constantly changing! The round hard atom of Newton which God alone could break into pieces has become a molecule composed of many atoms, and each of these smaller atoms has become so elastic that after vibrating 100,000 times its amplitude of vibration is scarcely diminished. It has become so complicated that it can vibrate with as many thousand notes. We cover the atom with patches of electricity here and there and make of it a system compared with which the planetary system, nay the universe itself, is simplicity. Nay more: some of us even claim the power, which Newton attributed to God alone, of breaking the atom into smaller pieces whose size is left to the imagination. Where, then, is that person who ignorantly sneers at the study of matter as a material and gross study? Where, again, is that man with gifts so God-like and mind so elevated that he can attack and solve its problem?

To all matter we attribute two properties, gravitation and inertia. Without these two, matter cannot exist. The greatest of the natural laws states that the power of gravitational attraction is proportional to the mass of the body. This law of Newton, almost neglected in the thoughts of physicists, undoubtedly has vast import of the very deepest meaning. Shall it mean that all matter is finally constructed of uniform and similar primordial atoms, or can we find some other explanation?

That the molecules of matter are not round we know from the facts of crystallography and the action of matter in rotating the plane of polarization of light.

That portions of the molecules and even of the atoms are electrically charged, we know from electrolysis, the action of gases in a vacuum tube and from the Zeeman effect.

That some of them act like little magnets we know from the magnetic action of iron, nickel and cobalt.

That they are elastic the spectrum shows, and that the vibrating portion carries the electrified charge with it is shown by the Zeeman effect.

Here, then, we have made quite a start in our problem; but how far are we from the complete solu-

*Address delivered to the Physical Society of America by the president at its meeting in New York, October 28, 1899, and published in The American Journal of Science.

tion? How can we imagine the material of which ordinary or primordial atoms are made, dealing as we do only with aggregation of atoms alone? Forever beyond our sight, vibrating an almost infinite number of times in a second, moving hither and yon with restless energy at all temperatures beyond the absolute zero of temperature, it is certainly a wonderful feat of human reason and imagination that we know as much as we do at present. Encouraged by these results, let us not linger too long in their contemplation, but press forward to the new discoveries which await us in the future.

Then as to electricity, the subtile spirit of the amber, the demon who reached out his gluttonous arms to draw in the light bodies within his reach, the fluid which could run through metals with the greatest ease but could be stopped by a frail piece of glass! Where is it now? Vanished, thrown on the waste heap of our discarded theories, to be replaced by a far nobler and exalted one of action in the ether of space.

And so we are brought to consider that other great entity—the ether; filling all space without limit, we imagine the ether to be the only means by which two portions of matter distant from each other can have any mutual action. By its means we imagine every atom in the universe to be bound to every other atom by the force of gravitation and often by the force of magnetic and electric action, and we conceive that it alone conveys the vibratory motion of each atom or molecule out into space to be ever lost in endless radiation, passing out into infinite space or absorbed by some other atoms which happen to be in its path. By it all electromagnetic energy is conveyed from the feeble attraction of the rubbed amber through the many thousand horse-power conveyed by the electric wires from Niagara to the mighty rush of energy always flowing from the sun in a flood of radiation. Actions feeble and actions mighty from inter-molecular distances through inter-planetary and inter-stellar distances until we reach the mighty distances which bound the universe—all have their being in this wondrous ether.

And yet, however wonderful it may be, its laws are far more simple than those of matter. Every wave in it, whatever its length or intensity, proceeds onward in it according to well known laws, all with the same speed, unaltered in direction from its source in electrified matter, to the confines of the universe unimpaired in energy unless it is disturbed by the presence of matter. However the waves may cross each other, each proceeds by itself without interference with the others.

So, with regard to gravitation, we have no evidence that the presence of a third body affects the mutual attraction of two other bodies or that the presence of a third quantity of electricity affects the mutual attraction of two other quantities. The same for magnetism.

For this reason the laws of gravitation and of electric and magnetic action, including radiation, are the simplest of all laws when we confine them to a so-called vacuum, but become more and more complicated when we treat of them in space containing matter.

Subject the ether to immense electrostatic, magnetic or gravitational forces, and we find absolutely no signs of its breaking down or even change of properties. Set it into vibration by means of an intensely hot body like that of the sun, and it conveys many thousand horse-power for each square foot of surface as quietly and with apparently unchanged laws as if it were conveying the energy of a tallow dip.

Again, subject a millimeter of ether to the stress of many thousand, nay even a million, volts, and yet we see no signs of breaking down.

Hence the properties of the ether are of ideal simplicity and lead to the simplest of natural laws. All forces which act at a distance always obey the law of the inverse square of the distance and we have also the attraction of any number of parts placed near each other equal to the arithmetical sum of the attractions when those parts are separated. So also the simple law of ethereal waves which has been mentioned above.

At the present time, through the labors of Maxwell, supplemented by those of Hertz and others, we have arrived at the great generalization that all wave disturbances in the ether are electromagnetic in their nature. We know of little or no ethereal disturbance which can be set up by the motion of matter alone; the matter must be electrified in order to have sufficient hold on the ether to communicate its motion to the ether. The Zeeman effect even shows this to be the case where molecules are concerned and when the period of vibration is immensely great. Indeed, the experiment on the magnetic action of electric convection shows the same thing. By electrifying a disk in motion it appears as if the disk holds fast to the ether and drags it with it, thus setting up the peculiar ethereal motion known as magnetism.

Have we not another case of a similar nature when a huge gravitational mass like that of the earth revolves on its axis? Has not matter a feeble hold on the ether sufficient to produce the earth's magnetism?

But the experiment of Lodge to detect such an action apparently showed that it must be very feeble. Might not his experiment have succeeded had he used an electrified revolving disk?

To detect something dependent on the relative motion of the ether and matter has been and is the great desire of physicists. But we always find that, with one possible exception, there is always some compensating feature which renders our efforts useless. This one experiment is the aberration of light, but even here Stokes has shown that it may be explained in either of two ways: first, that the earth moves through the ether of space without disturbing it, and second, if it carries the ether with it by a kind of motion called irrotational. Even here, however, the amount of action probably depends upon relative motion of the luminous source to the recipient telescope.

So the principle of Döppler depends also on this relative motion and is independent of the ether.

The result of the experiments of Foucault on the passage of light through moving water can no longer be interpreted as due to the partial movement of the ether with the moving water, an inference due to imperfect theory alone. The experiment of Lodge, who attempted to set the ether in motion by a rapidly rotating disk, showed no such result.

The experiment of Michelson to detect the ethereal wind, although carried to the extreme of accuracy, also failed to detect any relative motion of the matter and the ether.

But matter with an electrical charge holds fast to the ether and moves it in the manner required for magnetic action.

When electrified bodies move together through space or with reference to each other we can only follow their mutual actions through very slow and uniform velocities. When they move with velocities comparable with that of light, equal to it or even beyond it, we calculate their mutual actions or action on the ether only by the light of our imagination, unguided by experiment. The conclusions of J. J. Thomson, Heaviside and Hertz are all results of the imagination and they all rest upon assumptions more or less reasonable, but always assumptions. A mathematical investigation always obeys the law of the conservation of knowledge; we never get out more from it than we put in. The knowledge may be changed in form, it may be clearer and more exactly stated, but the total amount of the knowledge of nature given out by the investigation is the same as we started with. Hence we can never predict the result in the case of velocities beyond our reach, and such calculations as the velocity of the cathode rays from their electromagnetic action has a great element of uncertainty which we should do well to remember.

Indeed, when it comes to exact knowledge, the limits are far more circumscribed.

How is it, then, that we hear physicists and others constantly stating what will happen beyond these limits? Take velocities, for instance, such as that of a material body moving with the velocity of light. There is no known process by which such a velocity can be obtained, even though the body fell from an infinite distance upon the largest aggregation of matter in the universe. If we electrify it, as in the cathode rays, its properties are so changed that the matter properties are completely masked by the electromagnetic.

It is a common error which young physicists are apt to fall into to obtain a law, a curve or a mathematical expression for given experimental limits and then to apply it to points outside those limits. This is sometimes called extrapolation. Such a process, unless carefully guarded, ceases to be a reasoning process and becomes one of pure imagination specially liable to error when the distance is too great.

But it is not my purpose to enter into detail. What I have given suffices to show how little we know of the profounder questions involved in our subject.

It is a curious fact that, having minds tending to the infinite, with imaginations unlimited by time and space, the limits of our exact knowledge are very small indeed. In time we are limited by a few hundred or possibly thousand years, indeed, the limit in our science is far less than the smaller of these periods. In space we have exact knowledge limited to portions of our earth's surface and a mile or so below the surface, together with what little we can learn from looking through powerful telescopes into the space beyond. In temperature our knowledge extends from near the absolute zero to that of the sun, but exact knowledge is far more limited. In pressures we go from the Crookes vacuum still containing myriads of flying atoms to pressures limited by the strength of steel, but still very minute compared with the pressures at the center of the earth and sun, where the hardest steel would flow like the most limpid water. In velocities we are limited to a few miles per second. In forces to possibly 100 tons to the square inch. In mechanical rotations to a few hundred times per second.

All the facts which we have considered, the liability to error in whatever direction we go, the infirmity of our minds in their reasoning power, the fallibility of witnesses and experimenters, lead the scientist to be specially skeptical with reference to any statement made to him or any so-called knowledge which may be brought to his attention. The facts and theories of our science are so much more certain than those of history, of the testimony of ordinary people on which the facts of ordinary history or of legal evidence rest, or of the value of medicines to which we trust when we are ill, indeed to the whole fabric of supposed truth by which an ordinary person guides his belief and the actions of his life, that it may seem ominous and strange if what I have said of the imperfections of the knowledge of physics is correct. How shall we regulate our minds with respect to it? There is only one way that I know of, and that is to avoid the discontinuity of the ordinary, indeed the so-called cultivated legal mind. There is no such thing as absolute truth and absolute falsehood. The scientific mind should never recognize the perfect truth or the perfect falsehood of any supposed theory or observation. It should carefully weigh the chances of truth and error and grade each in its proper position along the line joining absolute truth and absolute error.

The ordinary crude mind has only two compartments, one for truth and one for error; indeed, the contents of the two compartments are sadly mixed in most cases; the ideal scientific mind, however, has an infinite number. Each theory or law is in its proper compartment, indicating the probability of its truth. As a new fact arrives, the scientist changes it from one compartment to another, so as, if possible, to always keep it in its proper relation to truth and error. Thus the fluid nature of electricity was once in a compartment near the truth. Faraday's and Maxwell's researches have now caused us to move it to a compartment nearly up to that of absolute error.

So the law of gravitation within planetary distances is far toward absolute truth, but may still need amending before it is advanced farther in that direction.

The ideal scientific mind, therefore, must always be held in a state of balance which the slightest new evidence may change in one direction or another. It is in a constant state of skepticism, knowing full well that nothing is certain. It is above all an agnostic with respect to all facts and theories of science as well as to all other so-called beliefs and theories.

Yet it would be folly to reason from this that we need not guide our life according to the approach to knowledge that we possess. Nature is inexorable; it punishes the child who unknowingly steps off a precipice quite as severely as the grown scientist who steps over with full knowledge of all the laws of falling bodies and the chances of their being correct. Both fall to the bottom, and in their fall obey the gravitational laws of inorganic matter, slightly modified by the muscular contortions of the falling object, but not in any degree changed by the previous belief of the person. Natural laws there probably are, rigid and unchanging ones at that. Understand them, and they are beneficent; we can use them for our purposes and make them the slaves of our desires. Misunderstand them, and they are monsters who may grind us to powder or crush us in the dust. Nothing is asked of us as to our belief: they act unswervingly, and we must understand them or suffer the consequences. Our only course, then, is to act according to the chances of our knowing the right laws. If we act correctly, right; if we act incorrectly, we suffer. If we are ignorant, we die. What greater fool, then, than he who states that belief is of no consequence provided it is sincere!

An only child, a beloved wife, lies on a bed of illness. The physician says that the disease is mortal; a minute plant called a microbe has obtained entrance into the body and is growing at the expense of its tissues, forming deadly poisons in the blood or destroying some vital organ. The physician looks on without being able to do anything. Daily he comes and notes the failing strength of his patient, and daily the patient goes downward until he rests in his grave. But why has the physician allowed this? Can we doubt that there is a remedy which shall kill the microbe or neutralize its poison? Why, then, has he not used it? He is employed to cure, but has failed. His bill we cheerfully pay because he has done his best and given a chance of cure. The answer is ignorance. The remedy is yet unknown. The physician is waiting for others to discover it or perhaps is experimenting in a crude and unscientific manner to find it. Is not the inference correct, then, that the world has been paying the wrong class of men? Would not this ignorance have been dispelled had the proper money been used in the past to dispel it? Such deaths some people consider an act of God. What blasphemy to attribute to God that which is due to our own and our ancestors' selfishness in not founding institutions for medical research in sufficient number and with sufficient means to discover the truth. Such deaths are murder. Thus the present generation suffers for the sins of the past, and we die because our ancestors dissipated their wealth in armies and navies, in the foolish pomp and circumstance of society, and neglected to provide us with a knowledge of natural laws. In this sense they were the murderers and robbers of future generations of unborn millions and have made the world a charnel house and place of mourning, where peace and happiness might have been. Only their ignorance of what they were doing can be their excuse, but this excuse puts them in the class of boors and savages, who act according to selfish desire and not to reason and to the calls of duty. Let the present generation take warning that this reproach be not cast on it, for it cannot plead ignorance in this respect.

This illustration from the department of medicine I have given because it appeals to all. But all the sciences are linked together and must advance in concert. The human body is a chemical and physical problem, and these sciences must advance before we can conquer disease.

But the true lover of physics needs no such spur to his actions. The cure of disease is a very important object, and nothing can be nobler than a life devoted to its cure.

The aims of the physicist, however, are in part purely intellectual: he strives to understand the universe on account of the intellectual pleasure derived from the pursuit, but he is upheld in it by the knowledge that the study of nature's secrets is the ordained method by which the greatest good and happiness shall finally come to the human race.

Where, then, are the great laboratories of research in this city, in this country, nay, in the world? We see a few miserable structures here and there occupied by a few starving professors who are nobly striving to do the best with the feeble means at their disposal. But where in the world is the institute of pure research in any department of science with an income of $100,000,000 per year? Where can the discoverer in pure science earn more than the wages of a day laborer or cook? But $100,000,000 per year is but the price of an army or of a navy designed to kill other people. Just think of it, that one per cent. of this sum seems to most people too great to save our children and descendants from misery and even death!

But the twentieth century is near—may we not hope for better things before its end? May we not hope to influence the public in this direction?

Let us go forward, then, with confidence in the dignity of our pursuit. Let us hold our heads high with a pure conscience while we seek the truth, and may the American Physical Society do its share now and in generations yet to come in trying to unravel the great problem of the constitution and laws of the universe.

THE ARTIFICIAL HATCHING OF SALMON IN NORWAY.

As a result of a visit paid by Herr Landmark to the United States, a new departure has been made in connection with the artificial hatching of salmon in Norway. Formerly the young fry were allowed to escape as soon as they began to require food, and, therefore, when in a very delicate and defenseless condition. They are now retained in captivity, says The Journal of the Society of Arts, and fed four times a day upon the raw liver of slaughtered animals, until the autumn, after the system which obtains in America. According to Consul Nelson, of Bergen, the results of the first year's experiment at the government hatchery on the Drammen were satisfactory; on 280,000 ova treated, the loss was only two per cent., and in the middle of October about 211,000 fry were turned out, while the percentage of loss has been still further reduced of late years. A belief is prevalent among the coast fishermen that salmon and sea-trout spawn successfully in salt water, and in this connection a series of experiments were conducted under proper supervision, from which it appeared that (1) roe taken from salmon captured in a river, or from sea-trout which have remained until spawning time in sea water, cannot be successfully developed in salt water, and (2) salmon and sea-trout roe impregnated in fresh water may be

hatched out in brackish water containing a small percentage of salt up to eight or nine per mille, that is to say, rather less than one-third of the salt contained in the sea water on the Norwegian coast.

[Continued from SUPPLEMENT, No. 1250, page 20042.]

THE DEVELOPMENT OF IRON MANUFACTURE IN THE UNITED STATES IN THE PAST SEVENTY-FIVE YEARS.*

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IN 1864 the Bessemer process was introduced in this country. Its introduction and perfection will ever remain one of the most interesting epochs in the history of the iron business.

As already stated, the forge carpenter and millwright were superseded by the machinist. Immediately after the introduction of the three-high mill all the rail mills in the country were changed, and all the new ones that were built adopted the same plan. In fact, as Mr. B. F. Jones, one of the oldest, one of the leading, and one of the most practical and successful ironmasters in the country, and one of the very first to see the advantages of the system, said to me a short time since, it was the commencement of the great improvement which took place in the iron works after 1857 which paved the way for the introduction of the phenomenal "Bessemer" process, which, as the Hon. Abram S. Hewitt says, takes its rank with the great events which have changed the face of society since the time of the middle ages.

At this time the machinists before alluded to were called to the front to brave the danger and fight the great battles that have ever to be encountered in the introduction of new metallurgical processes, and in none were the difficulties more alarming and disheartening than in the Bessemer process. These men had now received a training which eminently fitted them for the duties they were called upon to perform. Having been inured to hard work, they entered into this new field with such an amount of energy and determination that it made failure impossible.

In witnessing the beautiful and interesting but simple process of blowing a heat of metal, and the regularity with which it is done at this time, and the quantity turned out, it is impossible for one wholly unacquainted with its early history to even in a measure realize the fear and anxiety of those who were responsible for the result. When a charge of metal was poured into the vessel, our anxiety commenced, and as the heat increased, our anxiety increased in a corresponding ratio, until both became intense. It was when the heat was greatest that accidents were most likely to happen. The refractory material with which the converters were lined, especially the bottoms, would become plastic, and when in that condition the effect of the heat and the blast would waste the tuyeres and bottoms away so rapidly that from one to three heats were all we could get off one bottom. Frequently they would give out at the first heat, then out would come the metal through the bottom; and having to use much water about the converter, the place under the vessel was at all times wet, and the result was explosions, often very dangerous, as the hot metal was blown in all directions, frequently inflicting serious injuries on the workmen, a calamity greatly dreaded and the cause of the gravest anxiety to those in charge. When an accident would occur anywhere about the works, the first question asked would be: "Is any one hurt?" If not, we would go to work at once to repair with that object only in mind. If, on the contrary, some of the workmen were killed or seriously injured, it was impossible to describe the distress of mind that the persons in charge had to endure. The anxiety one had when the charge was put in the vessel was increased with the heat until the heat was blown; but it did not end with the blowing of the heat. When the vessel was turned down, it sometimes went too far and some of the metal ran out, resulting frequently in a grand pyrotechnic display of an exceedingly dangerous character. The next operation was to get the metal in the ladle, which was generally not a very difficult one, but it would frequently burn through the ladle, and then the only thing that could be done was to let it run into the pit and order all hands out of the way, for fear of an explosion. As soon as the metal was set, all hands commenced to clean the pit, which was no easy task. Here were eight tons of molten steel in the pit burned fast to ingot moulds, bottom and sides of the pit, and to everything that would not burn up. If we were so fortunate as to get the ladle over the pit in good shape, our anxiety was not yet at an end. It quite frequently happened that the stopper would pull off the end of the rod; then we had to use what we called a pricker to open the nozzle from the bottom. If the metal happened to be cold, which at that time it was apt to be, the nozzle would freeze up, as we called it; then the metal would have to be poured out of the top of the ladle into the mould, cinder and steel all together, with the result that generally the most of it got into the pit; then, again, if we escaped an explosion, we still had a mess in the pit. Altogether the difficulties we encountered were enough to appal the bravest hearts. My brother George once said, when at Cambria, that he did not believe there was a man who ever went into the Bessemer business, and was responsible for the result, who did not at times wish he had never gone into it; and so far as my experience goes, I can fully verify it. And, further, I think that, if it had not been for the interesting and exciting character of the business, but few men would have been willing to endure the trouble and anxiety and to endure the physical labor and danger to which he and the workmen were constantly exposed long enough to have placed the business on a commercial basis.

Having alluded to the trouble we had with the converter tuyeres, which caused so much anxiety and loss of time, I will now explain how we got over the difficulty at once. We were only getting from two to four heats off a bottom, and then would have to turn the vessel down and put in tuyeres during the blow. It so happened that, at a time when we were having more than the usual trouble, the vessel was turned down and we were putting in two tuyeres when I was sent for, to go to the blast furnace, there being trouble there. As soon as the vessel was turned up I started for the furnace, not in the serenest frame of mind; on the way over I was thinking over some new device for making the bottoms so that they could be burned in order to make them harder and better able to resist the action of the blast, as I had been thinking that that was one of the troubles. As I went into the furnace I noticed some firebricks about 5 inches square and 16 inches in length, such as are used in blast-furnace lining. At once I ordered some of them sent over to the converting department, and as soon as I could I went over and had one of them placed on end in the bottom between the tuyeres and well rammed in with ganister, put in the oven and well dried and put in the vessel. Result: Twelve heats off one bottom.

From this time our troubles began to diminish, and instead of making ten and twelve heats per day we soon ran up to fifty and sixty heats in twelve hours, and some of the works are now making seventy and eighty. This system of making bottoms was at once generally adopted and is still in use.

I shall now turn to the rolling mill. As already stated, with the introduction of the three-high mill in 1857, the commencement of the great improvement in rolling mills and machinery connected with them took place. The rolls were made larger in diameter, better fitted up, and a more powerful and a much better class of engines was introduced, larger and better heating furnaces were built, and many labor-saving devices were introduced. But with the marvelously increased production of Bessemer steel, it was evident that a larger ingot must be used in order to prevent congestion in the pit furnaces and rolls. This, of course, involved the building of larger, heavier, and more rapid working machinery.

In 1868 the lamented Holley, who later on became the consulting engineer of the Bessemer works, and so remained until his death, and to whom the country is largely indebted for the introduction of the Bessemer process, and for many improvements and important suggestions in the art, built a three-high blooming mill at Troy, N. Y. This mill had the top and bottom rolls stationary, the middle roll being moved up and down, to suit the work, by four screws passing through the bearing carrying the rolls. In the bearing there was a thread corresponding to the thread on the screws, which screws were driven by power. He also had lifting tables, front and back, fitted with loose rolls, and the ingots were pushed into the rolls by hand both in front and in back.

In 1871 my brother George, then superintendent of the Cambria works, built a three-high blooming mill in which the middle roll was stationary and the top and bottom ones movable, with feed tables both front and back, and the rollers driven by power taken from the train. He also introduced what is called a "pusher" to adjust the ingot in a proper position on the table and also an arrangement for moving the ingot on the table in proper position to enter the rolls.

In 1872 we built at Bethlehem, Pa., a three-high mill in which all the rolls were fixed, with tables similar to those at Cambria, but driven by an independent power which very much simplified the arrangement of driving the tables. This is the plan of mill that was generally adopted, and for a moderate sized ingot and quick working is probably the best plan of mill. But for heavy ingots and for variety of work the reversing mills are preferable.

The rail trains are, with two exceptions, three-high, with larger rolls, very heavy housings and fittings, and more powerful engines, and generally have some kind of labor-saving device attached to the rolls. In fact, all the modern rail mills have introduced labor-saving machinery to such an extent that there is, comparatively speaking, but little left for man to do. This is to a great extent due to the introduction of steel, as it rarely either splits or cracks in rolling, while iron is ever liable to do both, which renders the use of delicate automatic machinery more difficult in rolling iron than in rolling steel.

Many instructive, interesting, annoying and amusing incidents which might be related occurred in connection with the almost magical developments which took place in the manufacture of iron and steel during my long association with the business. But time will not permit.

We left the blast furnaces in 1840, which, as before mentioned, was the commencement of the use of mineral coal, from which period the greatly increased production commenced. While there was no practical change in the principle of making pig iron, yet, the continued increase in size of the furnace, the increased pressure and quantity of blast, the introduction of the Whitwell system of firebrick stoves, the better understanding of furnace working, the increased knowledge of the chemistry of pig iron making—all these, coupled with the indefatigable determination of the men in charge, have contributed to bring about the unprecedented and phenomenal production which has so amazed the iron makers of the world.

In 1868 the manufacture of acid open-hearth steel commenced; but its progress was slow, and following the Bessemer, this process not being so interesting and exciting, did not command the attention and respect to which it was entitled. The fact that the Bessemer was in the lead and the machinery was already in use, and that the knowledge of refractory material and in the handling of the steel was acquired, made the introduction of the open-hearth process easy compared to the Bessemer. But the fact that it quietly made its way into general use does not in any way detract from its great usefulness, and, with the invention and introduction of the "Thomas" basic process and its application to the Siemens-Martin open-hearth system, it takes rank only second to Bessemer as one of the greatest metallurgical inventions of the age. And taking into consideration the character of our ores and coal, and their geographical location, the superiority of the metal produced by this process, for structural and machine purposes, may cause it in the near future to outrank the Bessemer in value and general usefulness.

When we look back to the commencement of the last half of the present century, and take a thoughtful survey of all the inventions and improvements that have taken place in the arts of metallurgy during this period, the complete reversal of the position that iron and steel formerly held in relation to each other, the superiority of steel over iron in the useful arts, and the immensely increased production, which is unparalleled in the history of metallurgy, it seems impossible to fully realize that so great a change could have taken place within so brief a time.

While we have properly received great credit for the unprecedented developments we have made in the iron and steel industry in the United States, we must not forget that it was the inventions of Cort, of Mushet, of Bessemer, of Siemens, and of Thomas that enabled us to accomplish such important results; and to them all civilized nations owe a debt of gratitude for the incomparable blessing their inventions have conferred on society.

Yet how few of us even for a moment think of the trials, troubles, disappointments, mental anxiety and bodily toil these men had to undergo in the perfection and introduction of their inventions, besides suffering the sneers and jibes of those who imagine that an inventor is nothing but a wild enthusiast, and treat him accordingly. The story of many inventors is truly pathetic, and none more so than that of the lamented Thomas. The personal side of the story of the inventor of the basic process can only be appreciated by the reading of his life.

It should not be forgotten that England is the birthplace and home of the Iron and Steel Institute, and much of our success is due to the information we have gained from the invaluable papers read at their meetings and the discussions that followed them. Here I wish to say that I would commit an act of ingratitude should I fail to give credit to the brave and noble workmen who, throughout my long connection with the business, have ever stood ready to meet any emergency, no matter what the danger or difficulty might be. All that needed to be said was, "Come, boys," but never "Go, boys," and if the difficulties were not insurmountable they were sure to be overcome; and too much credit cannot be given to these fearless and energetic men for the almost fabulous progress that has been made in the manufacture of iron and steel in this country.

Having already intimated that the United States was not the original home of the iron and steel industry, I will again refer to it.

When I look back to my early days in the iron business long, long ago, probably too long, it brings to mind one of the happiest periods of my life. After my daily labor was done I was free from all care until the next morning. After supper, at half-past six, then a simple meal, I returned to the works and helped the puddler, heater, or roller, as the case might be, until about ten o'clock. At that time the practical men, puddlers, heaters, and rollers, were generally Englishmen and Welshmen. After the heats were charged in the furnaces, and while waiting for the charges to become heated, they would get their pipes—"cutty" they called it—and sit down on a pile of pig or puddled iron, as happened to be most convenient, and take their smoke. Having gained their confidence, I would take a seat by them, and then they would tell me about the works in England and describe how their mills were arranged, their system of rolling, the principle and construction of their puddling and heating furnaces, and how to work them. As I spent my nights in assisting them to puddle, heat, and roll, I gained a very general practical knowledge of the manufacture of wrought iron, which soon became of great value to me; and to the nights spent in the works with these hearty and generous workmen I owe much of whatever success I may have attained in after life. For the kind and generous manner in which I was always treated by them they ever have a green spot in my memory. In comparing this happy period of my life with what I have since many times gone through, it might, with propriety, be compared with the "Elysian Fields."

How little do the younger men that now have charge of our great iron and steel industries know or even think of the severe mental strain, the great amount of bodily toil, the vexation, the surprises, and the disappointments that had to be endured by the men in charge during the erection and perfection of these vast establishments that are now engaged in the manufacture of iron and steel. And, gentlemen, let me here say that this great work was not accomplished by command, but by example. It was the men in training, before alluded to, who erected, perfected, and put in operation these most marvelous enterprises of the age. And to these noble, brave and energetic men the people of this country owe a debt of gratitude for the far-reaching results they so thoroughly accomplished, and which have already changed the social condition of our vast territory. They have furnished us with a material which for quality and cheapness, and the quantity furnished in a given time, is without parallel, and could not have been realized by any other known methods. Without it the building of transcontinental roads would have been almost impossible. Had the rails been made in the old way out of the puddled iron, with the increased traffic on the Atlantic ends of the lines, they would be worn out before the Pacific coast could have been reached. The credit does not end here. The reduction of freight rates, owing to the general use of steel rails, is so enormous that it has been intimated by one of our most distinguished public men that the saving alone on the cost of transportation due to the use of steel in the place of iron would, if available, amount to a sum sufficient to pay our national debt in a comparatively short time.

In addition to the use of steel for rails, the Great West is being fenced with steel at a cost that seems almost fabulously cheap, and this product is being used largely for many other purposes. It was formerly iron that was used for structural work, now it is steel; and it has practically superseded the use of wrought iron. Steel is largely used in the construction of all grades of machinery employed in the manufacturing arts. It is the base of our immense inland system of transportation. It is this imperial metal that has enabled the engineer to perform the daring and remarkable engineering feats which he has accomplished during the last half of the century, without which they would have been practically impossible. It is the material used in the construction of these monster float-

* An address delivered in Convention Hall, National Export Exposition, Wednesday, October 4, on the Occasion of the Celebration of the Seventy-fifth Anniversary of the Franklin Institute.

ing palaces that cross the vast ocean with the regularity of a railroad train.

Fifty years ago steel was a luxury to the engineer. Modern practice of steel making in the hands of the mechanical engineer, the metallurgist, and the chemist has wrought wonders in producing a material which is used alike in the manufacture of articles of the most weighty, the rudest and cheapest grades, and in the construction of the most intricate, the finest and most delicate implements and machinery. And it is boldly asserting its value and importance through every walk of life.

It is to the invention, introduction, and perfection of the modern system of steel making in this country that we are indebted for the education of our people in the scientific, mechanical, and metallurgical arts, which has enabled them to erect such manufacturing plants as were necessary to supply our government with the sinews of war, which made it possible to achieve those glorious victories which at once placed us in the front rank among the nations of the earth.

I will conclude these reminiscences by giving some statistics compiled by the American Iron and Steel Association which show the wonderful progress that our iron and steel industries have made since 1840, when I started out to learn my trade as a blacksmith and machinist.

PRODUCTION OF ALL KINDS OF CRUDE STEEL IN THE UNITED STATES.

	Bessemer Ingots. Gross Tons.	Open Hearth Ingots. Gross Tons.	All Other Steel. Gross Tons.	Total Gross Tons.
1867	2,679	0	16,964	19,643
1895	4,909,128	1,137,182	68,524	6,114,834

PRODUCTION OF PIG IRON IN THE UNITED STATES.

	Gross Tons.
1840	286,903
1890	9,202,703
Estimated production for 1899	13,500,000

UNITED STATES.

Production of Pig Iron.—The total production of pig iron in the United States in the past eighty-six years is shown in the following table:

TOTAL PRODUCTION OF PIG IRON IN THE UNITED STATES FROM 1810 TO 1898.

Year	Long Tons.	Year.	Long Tons.
1810	53,908	1874	2,401,262
1820	20,000	1875	2,023,733
1830	165,000	1876	1,868,961
1840	286,903	1877	2,066,594
1850	563,755	1878	2,301,215
1854	657,337	1879	2,741,853
1855	700,159	1880	3,835,191
1856	788,515	1881	4,144,254
1857	712,643	1882	4,623,323
1858	629,548	1883	4,595,510
1859	750,560	1884	4,097,868
1860	821,233	1885	4,044,526
1861	653,164	1886	5,683,329
1862	703,270	1887	6,417,148
1863	846,075	1888	6,489,738
1864	1,014,282	1889	7,603,642
1865	831,770	1890	9,202,703
1866	1,205,663	1891	8,279,870
1867	1,305,023	1892	9,157,000
1868	1,431,250	1893	7,124,502
1869	1,711,287	1894	6,657,388
1870	1,665,179	1895	9,446,308
1871	1,706,793	1896	8,623,127
1872	2,548,713	1897	9,652,680
1873	2,560,963	1898	11,773,934

PRODUCTION OF PIG IRON, STEEL INGOTS AND CASTINGS, AND FINISHED IRON AND STEEL IN THE UNITED STATES FROM 1890 TO 1898 INCLUSIVE.

Years.	Pig Iron. Gross Tons.	Bessemer Steel Ingots and Castings. Gross Tons.	Open Hearth Steel Ingots and Castings. Gross Tons.	Total Steel Ingots and Castings Including Crucible. Gross Tons.	Finished Rolled Iron and Steel. All Kinds. Gross Tons.
1890	9,202,703	3,688,871	513,232	4,277,071	6,022,875
1891	8,279,870	3,247,417	579,753	3,904,240	5,390,963
1892	9,157,000	4,168,435	669,889	4,927,581	6,165,814
1893	7,124,502	3,215,686	737,890	4,019,995	4,975,685
1894	6,657,388	3,571,313	784,936	4,412,032	4,642,211
1895	9,446,308	4,909,128	1,137,182	6,114,834	6,189,574
1896	8,623,127	3,919,906	1,298,700	5,281,689	5,515,841
1897	9,652,680	5,475,315	1,608,671	7,156,957	7,001,728
1898	11,773,934	6,609,017	2,230,292	8,932,857	8,513,370

ANKYLOSTOMIASIS IN COAL MINES.*

UNDER date of August 29, 1899, Consul Roosevelt, of Brussels, transmits the following:

According to a royal decree published in the Moniteur Belge of August 27, 1899, the sections of the councils of industry and labor representing the coal industry are convened to meet to study a preliminary project elaborated by the government with a view to check the progress of "ankylostomiasis" in Belgian coal mines. The committee of each division will transmit to the Minister of Industry and Labor the agreements which have been adopted. In accordance with proposed regulations, a medical service and appropriate laboratory will be established and equipped for the purpose of thorough investigation of ankylostomiasis. Workmen will be obliged to submit to all hygienic measures ordered by the government and by this special service.

* Mr. Walcott, Director of the United States Geological Survey, informs the Bureau of Foreign Commerce that ankylostomiasis is a disease produced by Ankylostomum duodenale nematoid, a worm found in northern Italy and Egypt, parasitic in upper part of small intestine of man. It produces a fatal form of anæmia which has been named Egyptian chlorosis, Saint Gothard tunnel disease, etc.

DALOU'S "TRIUMPH OF THE REPUBLIC."

DALOU'S monument, called the "Triumph of the Republic," erected at Paris upon Place de la Nation, was inaugurated on the 19th of November.

Although the symbolism of this work of art is very clear, and free from any psychological subtilty, it will, nevertheless, be profitable to point out its details, even if it be, to the credit of its author, merely to call attention to the simplicity of its conception and the consummate art through which he was able to produce a peerless work.

At the top of a triumphal car, to which two lions are harnessed, the Republic is seen standing upon a globe. Wearing the Phrygian cap, and draped with a tunic of which the light folds permit the form of the body to be perceived, she holds out her right hand in a protective gesture, and with her left leans upon a fasces, the symbol of the union which makes strength. Seated upon the hind quarters of one of the lions, the genius of Liberty brandishes a torch, while two figures push the car forward. On one side stands a robust figure representing Work, and on the other a female with austere face representing Justice. Behind them, fecund lands of flowers and leaves running among the motives, everything concurs toward the equilibrium and harmony of the whole.

Power and nobleness in conjunction with elegance are, however, the characteristics of Dalou's talent. Faithful to the great tradition of Pierre Puget, he possesses to a high degree the sense of decorative sculpture, and also recalls the best French masters of the eighteenth century, but in giving free rein to the vigor of his own personal temperament.

The story has already been told of the genesis and history of this "Triumph of the Republic;" how Dalou, obliged to take refuge in England after the Commune, conceived the work in exile; how, despite the votes of the visitors to Melpomene Hall, he saw his clay model rejected from the competition; and how, in order to make amends to him for this rebuff, the city of Paris purchased it, and, in 1886, gave him a definite order to erect a monument upon Place de la Nation.

While pursuing his other work, the brave artist toiled unceasingly at this gigantic undertaking up to 1889. Ten years have passed since the provisional erection of the plaster cast. It should not be deduced

DALOU'S "TRIUMPH OF THE REPUBLIC."

Peace is distributing her benefits. The allegory is completed by children bearing various attributes.

But this brief description would give an inadequate and perhaps erroneous idea of the work did not our engraving, presenting a side view of the colossal group, permit of reconstructing the original physiognomy thereof.

Thus can be appreciated at its exact value what properly belongs to the artist, what his inspiration, aided by his science, has given birth to: the sovereign majesty of the figure of the Republic; the masculine vigor of the artisan with athletic muscles, and wearing the blacksmith's leather apron; the serene gravity of Justice; the bold aspect of the genius of Liberty; the smiling serenity of Peace; the gracefulness of the naked children, who seem to be proud of their symbolic burdens; and the superb carriage of the coupled thick-maned lions, one of which holds his head straight with disdainful calmness, while the other crunches the pole of the car between his teeth.

Although we may praise each figure for the accuracy and beauty of its expression and movement, we shall admire none the less the happy arrangement of the group, in which, from the disposition of the general lines to the skillfully arranged accessories, and the garfrom this that its transformation into bronze took so long a time. However, as may well be supposed, such transformation was no small affair. Intrusted to the Thiebaut establishment about three years ago, it required two and a half years of continuous work, which was performed by a force of a dozen workmen. It is not necessary to make our readers acquainted with the difficulties of casting, chiseling, and assembling pieces of such a size. All these operations, which the artist watched in person with constant vigilance, were directed by M. Charles Paret, foreman of the Thiebaut establishment, and a man of the greatest experience.

A few figures will serve to show the importance of the work. The car, inclusive of the sphere, is 21·3 feet in height, and the statue of the Republic 14·6. The other figures have a mean height of 14·4 feet. The lions are 13 feet in length. The total height of the monument is 36 feet. The material employed, at a thickness of 0·32 inch, weighs 83,600 pounds. The carriage of such a mass, piece by piece, required sixteen days, and the operation of putting in place lasted seven weeks.

For the above particulars and the engravings we are indebted to *L'Illustration*.

THE RAPID SEASONING OF WOOD THROUGH ELECTRICITY.

THE artificial aging of wood is a question that interests a large number of industries. Carpentry, joining, and cabinet making, to mention but a few of such industries, can employ no wood but that which has been cut for a sufficient length of time to allow it to acquire that resistance to humidity and variation in temperature and those other qualities which, according to the kind of work to be done, can be obtained only at the end of a long period of storage. In the manufacture of stringed instruments and pianos, no wood is used that has not been seasoned for fifteen or twenty years or more. In all cases, the manufacturer who must leave supplies untouched for various periods of time, locks up temporarily a large amount of capital. If, in addition, we reckon the rent of the space necessary for the storage of this wood, and the loss due to allowing the latter to lie idle for several years, the insurance, etc., we find that the net cost is increased by a very large amount. So, in order to remedy this state of things, an endeavor has for a long time been made to give newly cut wood the qualities of old wood artificially. It was at first thought that it would suffice to put the wood into drying rooms in which a properly calculated temperature would permit of drying and altering the sap quite rapidly. But, although this process succeeds with certain woods and with slight thicknesses, it gives bad results with certain kinds that split and with logs of great thickness. To the effect of temperature has been added the injection, by compression, of substances designed to replace the sap. But, even with very great pressures, the penetration takes place but imperfectly, especially in varieties of wood that have a very close texture, such as oak, or that have a resinous sap, such as pine. This process, for want of others, is employed for railroad ties, telegraph poles, and wooden paving blocks, but for carpentry, joining, cabinet working, etc., it is not practical.

It occurred to M. Nodon-Bretonneau that he might effect the displacement of the sap through the influence of an electric current, taking as a basis for such a process an experiment by Daniell that any one may repeat: We take a glass tube, *A B* (Fig. 3), bent at the extremities, and pour into it some acidulated water and a globule of mercury, *M*, and then place the tube horizontally, when all will remain at rest. But if we

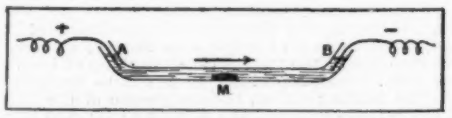

FIG. 3.—Daniell's Experiment upon which the Nodon-Bretonneau Wood Seasoning Process is Based.

insert the wires of an electric battery into the extremities of the tube, we shall see the globule of mercury move from the positive to the negative pole. In order to attain industrially the conditions favorable to the displacement of the sap, according to this principle, there has been constructed a wooden vat (Fig. 1) at the bottom, *C*, of which there is a frame forming a double bottom, covered with lead and connected with the positive pole of a dynamo.

Upon this frame (which may be raised by hydraulic jacks, *V*) the logs of wood to be treated are placed flat upon each other. Over them are arranged square and somewhat shallow boxes, of which the bottom is made of felt and canvas so as to form a sort of porous vessel, which is filled with water. A lining of lead permits of connecting these with the negative pole of the electric source. The vat is afterward filled with the solution designed to replace the sap in proportion as it is expelled. This solution may be antiseptic or incombustible. That which is generally employed is composed of neutral boro-resinate of soda. Care is taken not to submerge the pile of wood completely, and to arrange things in such a way that a space of a few inches shall exist between the porous vessels and the surface of the solution.

In addition, the latter is kept at a temperature of from thirty to forty degrees by means of a current of steam that is made to circulate in worms arranged at the bottom of the vat. The current traverses the entire thickness of the wood piled up between the lead beneath and the porous vessels and produces an electric endosmosis, so that the solution is, so to speak, sucked from the bottom to the top of the pile of wood and drives the sap before it and leaves it on the surface of the bath. The operation is finished at the end of a few hours, the impregnation being then complete.

The logs of wood are then removed from the vat and allowed to dry for a few days in the open air. The drying is then finished in a drying room in which the temperature is graduated. Upon being taken out of this room the wood may be employed immediately. We have seen some doors, boxes, pianos, etc., that were manufactured from wood treated by this process, and that, after a year's time, showed no trace of expansion or shrinkage. With the pianos, the sonorousness seemed to be increased.

The treatment succeeds better with freshly cut wood, in which the sap is in a liquid state, than with wood that is already partially dry and in which the coagulated sap obstructs the pores and prevents the penetration of the preserving solution. The net cost of this treatment is very variable according to circumstances. At Paris it is estimated that it is from about two to two and a half cents per cubic foot; but here the conditions are less favorable as regards the cost of motive power and manual labor. An installation such as that existing in the Magasins Generaux at Aubervilliers (Fig. 2) might work under better conditions if it were in proximity to forests and had hydraulic power at its disposal. There is another cause that may influence the net cost, and that is the treatment of the by-products; since from the sap that is expelled, various useful substances may be extracted.

For the above particulars and the illustrations, we are indebted to *La Nature*.

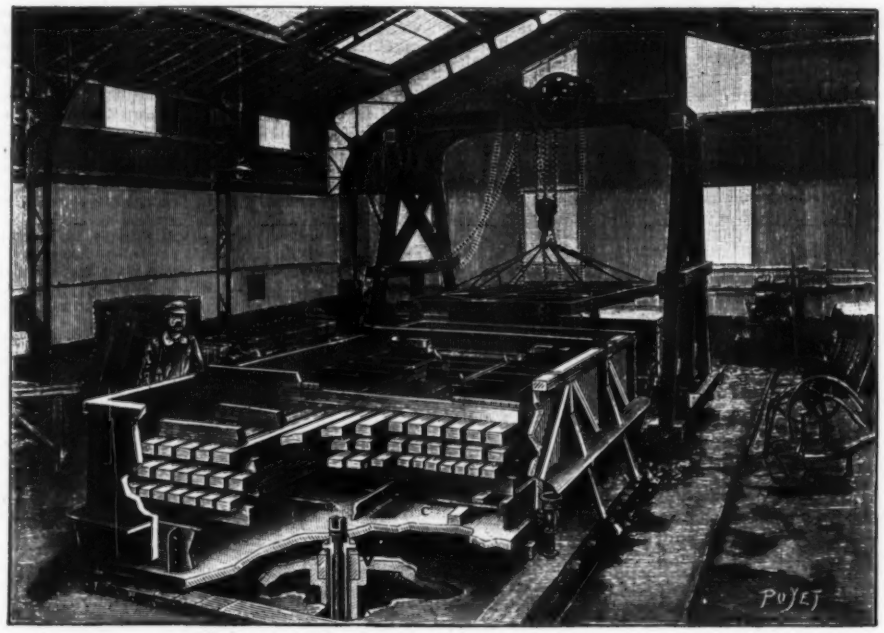

FIG. 1.—ARRANGEMENT OF APPARATUS FOR THE RAPID SEASONING OF WOOD.

THE ANDRÉE BUOY.

THE Andrée expedition took twelve buoys of peculiar make, each one consisting of a cork balloon painted with the Swedish colors (yellow and blue) and covered with a network of strong copper wire which terminated at the lower end in a spike of copper. In the upper end of the balloon there was an opening in which was secured a cylinder, that was closed at the lower end by means of a rubber packing and at the upper end screwed in the copper plate to which the netting was secured. On the plate the inscription "Andrée's Polar Expedition 1896 Nr . . ." was engraved. The inscription was dated 1896, the year for which the expedition was first planned, and was not altered although Andrée really started in 1897. The iron cylinder was designed to carry communications in writing. From the cylinder, which projects beyond the plate, extends a strong spiral iron wire, that terminates in a Swedish flag made of sheet iron. This arrangement is very practical, for if the buoy is thrown into the water it will always fall with the copper spike down, and if it falls on the ground or on ice, the spike will bore in so that the flag will always be uppermost. The buoy which was found is 12·5 inches long, and has been declared by several experts who met in Stockholm on October 1 to be the so-called "North Pole buoy"; that is, the buoy Andrée was to have thrown out after the North Pole had been passed. Capt. Svedenborg, who has had experience in balloon ascensions, explained that the hooks seem not to have been fastened on the eyes and that consequently the buoy was not let down by means of lines. The buoy was opened. The copper network was cut off at its lower edge, where upon sea sand fell out; and when the copper spike with the copper tube secured thereto was taken out, the latter held some water—and the tube was sawed off. In the lower part they found a rubber stopper on which was some gravel. On the inner side of the tube there was a paper-like lining which the microscope showed to be a sort of seaweed. Prof. Nathorst explained that the buoy could not have traveled from

THE ANDRÉE BUOY.

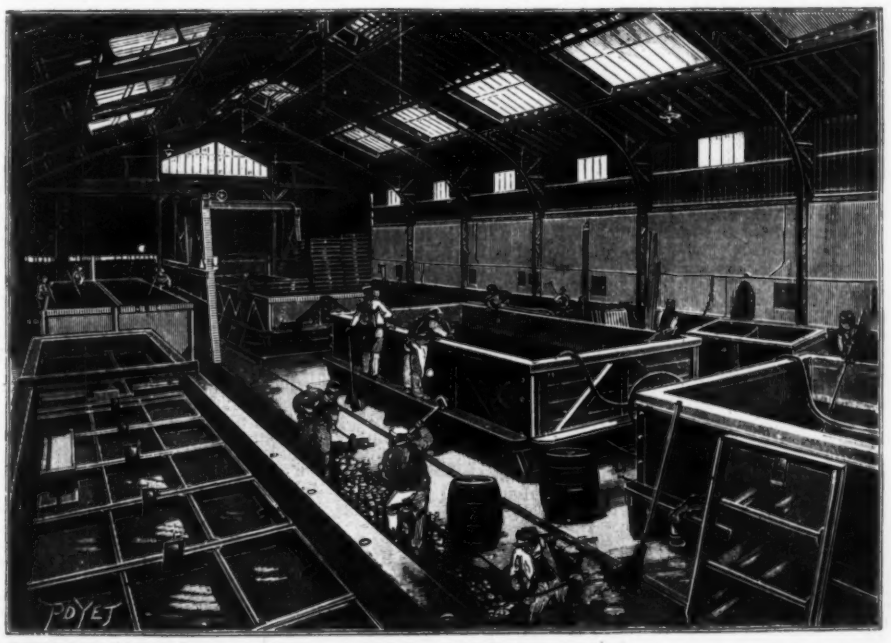

FIG. 2.—INTERIÒR OF THE SEASONING ROOM AT THE MAGASINS GENERAUX OF LA VILLETTE.

the Pole to King Charles Land. Svedenborg thought the buoy had been thrown out empty, and Prof. Montelius maintained that it had not been proved that the buoy had been thrown out empty. Nordenskjold thought that King Charles Land should be searched in 1900. Fridtjof Nansen, who was asked for his opinion, thought that the finding of the buoy was a bad sign. He said: "I believe that the unfortunates threw out this buoy and much else, not in order to send information, but as ballast. Of course they could not throw out provisions. They still needed them, but they already knew that they would no longer need the buoy, poor fellows! I have no hope that they have been rescued and are still living." In Nansen's opinion the buoy was thrown out beyond Spitzenberg, apparently near Franz Joseph Land.—Ueber Land und Meer.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Steel Roadway in Spain.—The road between Valencia and Grao is 2 miles in length, and an average of 3,200 vehicles pass over it daily, says Consul H. L. Washington, of Valencia. Until 1892, it was constructed of flint stone. The annual cost of keeping it in repair was about 35,000 pesetas. At the rate of exchange at that date, this amounted to $5,470.

The construction of a steel roadway was determined on, and the annual cost of keeping in repair the central zone of road thus relieved from heavy traffic—which proceeds over the steel rails—is now only 2,500 pesetas, or about $380 at the present rate of exchange.

A Belgian firm received the contract to furnish the steel work, having bid less than Spanish firms at Barcelona and Bilbon.

The length of road so built is 3·2 kilometers (1,988 miles). The cost per kilometer (0·62137 mile) was 44,100 pesetas ($6,890).

The total cost of the road laid was 60,950 pesetas ($9,506). The expense in detail was:

	Pesetas.	
Steel construction	44,100	=$6,890
Transportation and laying steel construction	3,250	= 507
Binding-stone construction between rails and lateral zones	13,600	= 2,109
Total	60,950	=$9,506

The rails during the seven years they have been in position exhibit a wear of one decimal of a millimeter yearly, and have not required repairing.

Ample room is allowed between the rails for two horses to walk abreast. Horses do not appear to slip on rails of this construction.

At each side of the rail are layers of binding-stones, the paved road being higher than the face of the rails.

The municipality of Valencia is of opinion that the saving in cost of repairs, through a road of this description, pays for its construction in a short time, and other and similar roadways are in contemplation.

From various parts of Spain inquiries have been made concerning this road. I learn that a similar construction was decided on at Alicante, in 1898, but was temporarily abandoned when events caused exchange to increase.

A toll of about eight-tenths of a cent is charged each vehicle passing over this roadway.

A fuller description would have been furnished had it not been believed that the technically accurate working plans transmitted herewith would themselves prove of much greater information than unprofessional statements.

I am indebted to the mayor of Valencia and to Señor Mesegner, municipal architect, who invented the road, for copies of these plans.

French Wheat Crop of 1899.—Consul Atwell sends the following from Roubaix, under date of September 15, 1899:

The Exchange Bulletin has just published its estimate of the wheat crop in France and other countries. The provisional figures from France show a crop of 122,242,000 hectoliters (346,600,554 bushels) this year, against 131,050,220 hectoliters (372,049,474 bushels) in 1898. This is a falling off of 8,808,200 hectoliters (25,098,963 bushels) from last year, but an increase of 12,245,886 hectoliters (34,741,590 bushels) over the mean production of the last ten years, which is figured at 108,996,114 hectoliters (379,321,975 bushels). Taking the general needs of consumption in France at 124,000,000 hectoliters (380,158,000 bushels), the crop will meet the demand, if accounts be taken of the exceptionally abundant crop of last year, which has left a large unconsumed stock of old wheat available at present. The probable importation is figured at 1,500,000 hectoliters (4,255,500 bushels). This will probably be confined to hard wheat, which is not grown in France in sufficient quantity to meet the needs of manufacturers of alimentary pastes. The production of the world at large is estimated at 886,500,000 hectoliters (2,526,000,500 bushels), against 989,100,000 hectoliters (2,807,076,700 bushels) for last year, a decrease of 102,600,000 hectoliters (291,076,200 bushels). Comparing, however, the universal yield of this year with that of 1898, which was the most abundant ever registered, the deficit is not disquieting, as the yield of 1899 is about equal to the average.

Development of New Caledonia.—Commercial Agent Wolff, of New Caledonia, under date of August 2, 1899, says that not only the colony at large, but the city of Nouméa, have entered upon an era of prosperity. At a recent meeting of the municipal council, $130,000 was voted for public improvements. The mayor, M. Charles Lompias, requested Mr. Wolff to invite American firms to tender for the construction of a market hall. Mr. Wolff forwarded the information to a San Francisco firm. The stone quay, the finest in the Pacific, is well under course of construction, and the plant for the electric lighting of the town is being erected. An automobile service has been inaugurated for conveying the mails around the island, and the governor is authority for the statement that $700,000 will shortly be available for the construction of a dry dock at Nouméa, which enterprise Mr. Wolff also hopes to secure for an American firm.

Under date of August 4, 1899, Mr. Wolff adds that in consequence of the favorable reports made by experts during the year as to the mineral resources of New Caledonia, a number of foreign capitalists have been attracted to the colony. The Caledonia Copper Mining Company (the fifth of the kind), with a capital of $3,700,000, has recently been formed in London to exploit the inexhaustible Pilou mines in the north. The current of exportation of mineral ores to the United States has begun. A cargo of nickel is ready for a British ship from South Africa, which is to stop on its way to the United States. Other consignments will be effected in the near future.

Belgian Artificial Stone.—Consul Atwell, of Roubaix, on October 17, 1899, writes:

An artificial stone from Belgium has recently been introduced into the French market, which is said to have four times the force of resistance of French freestone and which has nearly all of the properties of Cobestang granite. It has been tried in the Malines arsenal and is found to be insensible to the action of cold, absorbs only 6 to 7 per cent. of water, even after a long dry spell, and cannot be crushed under a pressure of 40 kilogrammes (88,184 pounds) to the square centimeter. This artificial stone is manufactured at Uccles, near Brussels, in the following manner: Eighty parts of extremely clean and dry coarse sand are mixed with twenty parts of hydraulic lime reduced to a fine, dry dust; this mixture is put into an iron box, which is plunged into a boiler of water, and this is hermetically closed. During seventy-two hours, the cooking goes on under a pressure of 6 atmospheres, the temperature being maintained at 165°. At the end of this time, the iron box contains a perfectly homogeneous mass of stone, which rapidly hardens upon exposure to the air. The most varied colors are given to this stone, and its manufacture costs only 2 cents per cubic foot.

Railway Congress at Paris.—The Department has received from the Belgian legation, under date of New York, October 13, 1899, the programme for the sixth international congress of railways, which will meet September 15, 1900, at Paris. The subjects to be discussed are:

Section 1, Ways and Works.—Nature of metal for rails; rail joints; points and crossings; maintenance of way on lines with heavy traffic; methods of dealing with snow; construction and tests of metallic bridges; transition from a rising to a falling gradient; preservation of timber; ballast; creeping of rails.

Section 2, Locomotives and Rolling Stock.—Exhaust and draught in locomotives; locomotives for trains run at very high speed; stability of locomotive axles; banking, piloting, or double heading; purification of feed water of locomotives and use of disincrustants; use of steel and ingot iron in construction of locomotives and rolling stock; brakes and couplings of carriages and wagons; economical size of goods trucks or capacity of freight cars; electric traction; automotor vehicle.

Section 3, Traffic.—Train lighting; handling and conveyance of broken loads; long-distance goods trains; economical interlocking apparatus; automatic block system; signals for repeating visible signals; use of the telephone; safety appliances for preventing collisions arising from runaway wagons; sorting by gravitation; distribution of rolling stock.

Section 4, General.—Accounts; railway clearing houses; grouping of goods; technical education of railway servants—appointment and promotion; cooperative societies and stores under railway management; facilities for customs inspection.

Section 5, Light Railways.—Influence of light railways on national wealth; means of developing light railways; main lines crossed by light railways; conveyance of farm produce to stations on main railways; carriages and wagons for light railways; warming of carriages on light railways.

The programme gives the names of those who will report on the various subjects. Reports from United States representatives will be made in regard to nature of metal for rails; ballast; exhaust and draught in locomotives; locomotives for high speed trains; use of steel and ingot iron in the construction of locomotives and rolling stock; brakes and couplings; capacity of freight cars; electric traction; conveyance of broken loads; automatic block system; railway clearing house; technical education of railway servants; conveyance of farm produce to stations on the main railways.

Other matters which will be discussed are: Use of liquid fuel in locomotives; international passenger fares and goods tariffs; suburban passenger traffic; organization of funds for providing pensions to employes; benefit societies of Russian railways (old-age pensions, sick and accident funds, mutual loan arrangements, etc.)

The United States government is invited to send delegates to the congress.

Matches in Mexico.—In reply to a resident of New York, Vice-Consul Pagés writes from Veracruz, September 20, 1899:

The cost of efficient labor in manufactories is: Male, 50 cents to $1 per diem; female, 25 to 50 cents. In match factories, practically all the labor is task work. Women are employed outside the factory to give shape to the boxes. The usual workday is: In the higher altitudes, 6 A.M. to noon and 1 to 6 P.M.; in the hot districts, from 6 to 10 A.M. and 11 A.M. to 5:30 P.M.

Wood is the most economical fuel for stationary engines. It is worth about $7 Mexican = $3.36 gold; taking the valuation by the United States Director of the Mint, July 1, 1899, $1 Mexican = 48·1 cents per cord. Coal is worth about $5 gold per gross ton on board ship, Veracruz.

The principal factory in this State—Mendizabal & Company—which has branch factories in other parts of the Republic, is operated by French machinery, except the motor, which is from the United States. It employs about eighty men and boys. The women work at home. Most Mexican match factories are operated by machinery more or less elaborate.

Wax matches have almost entirely superseded the wooden matches formerly used in this country. The latter are still made in limited quantities and are preferred by some, but this preference is confined to the hot country and may be due, in part, to traditional prejudice. It is said that wooden matches are better for the hot country, as the wax is liable to melt and become sticky. The wax taper is less bulky, generally has two striking ends, emits no disagreeable odor, and is made waterproof. It is doubtful if a wooden match could be made to supplant the wax, unless a manifestly superior article were produced at a lower price.

There are no matches imported. White pine wood comes from the United States, and paraffin wax is furnished by the Mexican connection of the Standard Oil Company. Boxes with rubber strings are now imported from Italy. The consumption of matches put up in this form is very limited—about 100 gross per annum for the Veracruz factory.

The number of people who purchase matches is relatively large. A very heavy percentage of the male sex smokes, the consumption of cigarettes being enormous.

Demand for Boilers, Engines, etc., in Guadeloupe.—I have been asked to procure information regarding steam boilers, engines, accessories, etc., for the largest machine shop here. This shop is connected with the steamboat line of the island, says Louis H. Aymé, consul at Guadeloupe.

The manager particularly desires information regarding portable steam boilers, mounted on wheels; marine engines for small steamers; marine boilers; steam and safety valves; lubricators; steam and vacuum gages; ordinary steam pumps; ordinary pumps; steam fire engines, small; centrifugal pumps; horse power rigs, with and without shafting or other gear for transmitting power.

In every case illustrated catalogues, in French if possible, are desired and the following information: Weights, net and boxed or packed for shipment; dimensions; price f. o. b. New York city. Exterior elegance and beauty of appearance are not so much desired as solidity, efficacy, and cheapness.

The discriminating duties against our machinery are very great, and have heretofore totally discouraged the importation of such articles, but last spring the experiment of bringing two small portable boilers and some other articles from the United States was made. The manager referred to thus expresses himself:

"When they came, we were much disappointed. They looked rough and ugly, and we are accustomed to receive from France similar goods that are very beautiful and graceful to look at. But when we came to examine the interior, we were most pleasantly surprised—perfect adjustment, exquisite fittings, the minimum of friction and lost motion and maximum of efficiency and solidity. Your machines are incomparably better than our own in these respects, and much cheaper. If it were not for the enormous tariff, we would use no others; but in spite of this, we want to see if we can not buy from you. If your manufacturers will help us, we can do it. Let them give us cheap, solid, honest work, with no expense for mere outside appearance, putting the finish only where it is needed; packing the goods as lightly as is consistent with strength and safety in transportation; and quoting us bottom prices free on board in New York city (for we can not consider your inland freights, etc.) I believe that we will find the advantages of efficiency and durability sufficient to warrant our purchasing all such goods from the United States. Of particular interest are the horse power rigs, an apparatus by which horses traveling in a circle drive a shaft through which power can be supplied to small machinery, pumps, etc., on sugar estates. If we can get our information and carry on our correspondence in French, it would be a very great advantage."

I have quoted him at length, as he covers the ground completely. The people he represents are of the very best financial standing.

I shall be pleased to receive catalogues, price and discount lists from manufacturers of the various articles above enumerated, and will do all in my power to foster the introduction of our machinery here. To succeed, however, honest workmanship, good materials, absence of useless and expensive adornment, and low prices are imperative. These people are slow to change, and if our goods can once get a foothold here, we can hold the trade for all time.

Demand for Iron Theaters in Spain.—Consul Bartleman, of Malaga, under date of September 22, 1899, says:

I have been requested to obtain from firms in the United States prices, plans, and specifications for a cheap and pretty theater, with a seating capacity of about six hundred, the same to contain one or two balconies, and to be constructed of sheet or corrugated iron. Any communications addressed to me will be delivered to the parties interested.

Cotton Mills in India.—Consul Fee sends the following from Bombay, October 13, 1899:

A meeting of the Mill Owners' Association, of Bombay, has been called for the 17th instant, to consider the question of the "short time" working of local cotton mills. The proposition that will be brought before the meeting is that, in consequence of the failure of the cotton crops and the present high prices of cotton, the local mills should be worked only four days per week. Messrs. Greaves, Cotton & Company, agents for a group of seven mills, took the initiative to-day by closing them. They have resolved to work only on Mondays, Tuesdays, Thursdays, and Fridays.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 594. December 4.—*A German Expert View of the American Iron and Steel Industries—Cotton Goods in Shanghai.

No. 595. December 5.—Auction of Siberian Mining Land—Electric Tramway in Calais.

No. 596. December 6.—Lumber Trade in Rotterdam—Fishing in Iceland—Antwerp Ivory Market—Shoe Trade in Belgium—Crops in Ontario.

No. 597. December 7.—*The Iron and Steel Trade in Germany—Bremen as a Cotton Market—Coal at Gibraltar—Prevention of Rot in Potatoes.

No. 598. December 8.—Estimate of the Year's Sugar Crop—New System of Telegraphy.

No. 599. December 9.—Cacao in Samoa—Sole Leather in Japan—Swedish Regulations on Imports of Horse Meat—New Russian Railways.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

MISCELLANEOUS NOTES.

In the Portland cement industry a quick-drying apparatus recently patented is creating quite a stir. There being an urgent need of such an apparatus, many attempts have been made to invent one satisfying all the demands made upon it, but so far without success. The inventor of the new construction places a movable drum containing the material to be dried in the heating chamber. This drum is fitted with openings through which the fuel gases enter into the material, while caps provided at the openings prevent the falling out of the stuff. This apparatus, compared with former styles, furnishes eight to twelve times the evaporative effect and works economically, 1 kilo of Westphalian coal vaporizing 10 kilos of water.—Technische Berichte.

Seven hundred and fifty-five locomotives were built at the Baldwin Locomotive Works last year, of which number 348 were exported. Two hundred and forty-two locomotives, or 32·05 per cent. of the output, were compound engines, and the rest single-expansion. Of the compound locomotives, 235 were of the four-cylinder type, and seven were of the two-cylinder type. The output for the current year will again exceed that of the previous year, the works being organized on an estimated output of 1,000 locomotives, or three and a half per day. This entails a continuous run of twenty-four hours in shifts in the principal departments, the employment of 5,800 men at ten hours per day, and the use of 5,000 horse power. The approximate weekly consumption of the works comprises 1,000 tons of coal and 1,500 tons of iron.—Trade Journals Review.

A gas similar to that from coal is obtained when wood is distilled in a closed chamber (observed M. Letombe to the members of the Société Industrielle du Nord de la France); but the disadvantage is that this gas requires a complicated purification. M. Riche has, however, conceived the idea of doing away with all the purifying appliances by making the gas pass over charcoal heated to redness, either operating by reversed distillation or by employing twin retorts. The gas thus obtained is comparatively rich, since it has a calorific power of about 3,000 calories per cubic meter and contains no hydrogen. Although this gas is not illuminating, it is suitable for motive power; and the method is chiefly important for regions where wood is cheap and abundant. Relying on the sale of the by-products, the makers of the Riche gas producer hope to arrive at a very low price for the horse power, in which case wood might compete with coal; but it does not appear likely that this gas will ever be able to compete successfully with poor gas.—Engineering and Mining Journal.

One of the neatest devices we have seen for shifting open and cross belts in a reversing gear, without the necessity for a broad fast pulley in the middle, or a narrow fast pulley with two loose ones of double breadth at each side, is shown in a contribution to Machinery for October. There are three pulleys, each the breadth of the belts, the middle one being fast, and the two outsides loose. The peculiar feature of this device is in the shifting bar, which is square and carried by two hangers in the usual way; but the two forks which guide the belts are a loose fit on this bar, and are kept the proper distance apart by a few wide coils of a spiral spring wound around the bar. There are feathers on the bar outside of the forks to keep them from spreading too wide apart, and these serve to push each fork with its belt on to the fast pulley. The advantage of this arrangement is that only one belt fork moves at a time, carrying either open or crossed belt, as desired, on to the fast pulley or vice versa. We have seen many schemes for effecting this object, but we know of none that is simpler or that can be so easily rigged up as this.

A rotary planing machine for facing off the ends of structural-iron work has long been known; and when beams have to be faced at right angles to their length, the rotary cutter serves the purpose admirably. But when beams which have been cut off at an angle are to be handled, the fixed base machine requires the angle to be obtained by swinging the beam round to bring the angle in line with the movement of the cutter-head; and in the case of long beams, this means a considerable area clear in front of the machine, which it is sometimes inconvenient to provide. The handling of the beams is also troublesome, and attended with loss of time. In a contemporary we notice an illustration of a rotary planer which is designed to avoid these objections. Instead of slewing the beam to give the required angle, the cutter-head is mounted on a turntable base, whereby it may be swung about a vertical pivot to cut at any angle desired. The beams thus occupy the same position on table regardless of the angle at which the cut is made. The ability to turn the cutter-head is then the only respect in which this product of a Massachusetts concern differs from ordinary rotary planers. A saving of space is the principal advantage.

An interesting bit of history recently given in Electricity, concerning acetylene gas, shows the remarkable genesis of that peculiar article. It was discovered some years ago, by Thomas L. Wilson, of St. Thomas, Ont., and this was while smelting for metallurgical purposes. From time to time he used a great deal of rock salt in his furnace stock, and also limestone as a flux; whenever these two were fused together, the slag produced by the immense electrical heat included a dirty grayish substance, wholly unlike anything he had ever seen. He simply dumped this stuff into the stream near the furnace. One day, when the pile of slag was so large that its top rose above the surface of the water, a minute or two after dropping the slag as usual into the stream—some of it underneath and some remaining above the water in a red hot state—the sizzling and steaming was followed by a bright burst of flame. The next time rock salt and limestone were used the blaze again appeared over the slag after it had been cast into the river, and it being at night he was much struck by the brilliant white light, so that on again having a batch of the queer grayish residue to dispose of he did not waste it but saved and poured over it some water for experiment. To Mr. Wilson's surprise there was not any flame, but after puzzling a while over this feature he held a lighted match over the pile, when instantly there was a white, glowing flame.

TRADE NOTES AND RECEIPTS.

A New Disinfectant.—Kroenig and Paul have obtained a new disinfectant by mixing 45 c.cm. of concentrated hydrochloric acid with 1,600 c.cm. of water and 500 c.cm. of 4 per cent. potassium permanganate solution. The most resistive sporales are destroyed by this disinfecting agent, says Neueste Erfindungen und Erfahrungen. It stains the skin, but the spots can be removed with a ten per cent. oxalic acid solution, or with a five per cent. hydrochloric acid solution.

Paste for Paper, Leather, etc.—Weigh out equal parts of starch, animal glue and turpentine oil, stir the starch with water into a rather stiff paste, dissolve in another vessel the glue in sufficient water on the water-bath, pour the turpentine oil into the last named solution and the starch paste into this mixture. Heat the whole moderately, with stirring, till evenly mixed. This paste can be kept for a long time, can be used cold, dries quickly, and does not smut. It may be diluted with water as required.—Papier Zeitung.

Hazel-nut Oil contains according to J. Hanus 85 per cent. of oleic acid, 10 per cent. of palmitic acid and stearic acid, 10·41 per cent. of glycerine (calculated from the saponification number) and 0·50 per cent. of phytosterine. The constants are:

Specific gravity at 15° C.	0·9169
Saponification number	193·7
Iodine number	90·2
Hehner's number	95·6
Reichert-Meissl number	0·99
Acetyl number	3·2

—Zeitschrift für Untersuchung der Nahrung- und Genussmittel.

Are Asphalt Fumes Injurious to Vegetation?—This question has long been disputed, but latterly, an expert, Professor Sarauer, has conducted closer experiments which have established the fact that the answer should be in the affirmative. Rooted plants were exposed to these vapors for several hours in a tightly closed green-house. The majority of the plants were after three hours removed to the open air, seemingly without having suffered any injury. But after one to three days, especially roses, strawberries and horse chestnuts, exhibited a peculiar black discoloration of the foliage, entirely different from the effect of other fumes and smoke. Other plants showed a whitish discoloration. At any rate, concludes a writer in the Staats Zeitung, the asphalting of streets containing plants should be performed with caution.

Indelible Design on Veneer.—The process consists in marking the desired design, etc., in dotted lines on the face of the veneer with black chalk or blue pencil, subsequently executing it neatly with a special impregnating substance by means of a steel pen, and allowing to dry.

The impregnating mass is composed of lamp black 60 parts, blue vitriol 100 parts, spirit 30 parts.

After the drying of the tracing, the veneers are washed for twenty hours in clear water which is constantly changing. The result is that the sketch is not only fixed, but will finally appear on the back of the veneer, penetrating it entirely, since the design, both as regards outlines and whole surfaces, is not only applied on the respective veneer, but penetrates it. This method affords a cheap and durable substitute for the mosaic plates heretofore employed for this purpose, because the finished work consists, as before, of one piece, whose structure is not cut into.—Deutsche Maler-Zeitung.

Rubber in Para.—The districts producing most rubber in the State of Para are the islands on the Amazon River. The banks of the Tocantin River, the banks of the rivers Zingu, Jary and Tapajos, the upper and lower districts of the Amazon River, produce the same kind of rubber, but the article coming from the upper portions of the river generally fetches a higher price, because it becomes somewhat drier in time. The harvest of rubber begins in those districts about July, ending in January or February. In the rainy season no harvesting is done, as a rule. The persons employed in gathering the rubber are mainly Brazilians. The South American Indian is little suited for this work. He makes little demands upon life, subsisting chiefly by fishing and hunting, hence is less dependent upon work than more civilized people. Many attempts have been made to simplify the working of the crude rubber by machinery, but all these efforts have been unsuccessful since the ordinary method, though very primitive, has the advantage of being very simple and cheap.—Technische Berichte.

Distinguishing Genuine from Artificial Silk.—For this purpose Heerman gives the following process:

(*a*) Artificial silk dissolves in alkali with a yellow color, natural silk with a white color.

(*b*) Artificial silk is insoluble in an alkaline copper solution containing glycerine (copper sulphate 10 grammes, water 100 c. cm., glycerine 5 grammes and enough caustic potash so that the resulting precipitate is dissolved), while natural silk dissolves in it at an ordinary temperature. The process also allows of a separation and quantitative estimation of the two varieties of silk in mixtures.

(*c*) Artificial silk gives with diphenylamine and brucine nitric acid reaction, while the natural does not. The fundamental substance in artificial silk is known to be nitro-cellulose, while natural silk consists of albuminoids. The various factories use different processes, viz.:

(*a*) Chardonnet nitrates cellulose and dissolves in alcohol ether, coagulating with alcohol or diluted nitric acid, denitrating with diluted nitric acid, ferrous chloride, ammonium phosphate, etc. The product is glossy, pliant and possesses the feel of silk.

(*b*) Du Vivier dissolves trinitro-cellulose in glacial acetic acid, coagulates with a secret liquid, and denitrates with 20 per cent. of fish glue and 10 per cent. of gutta percha. The silk is more brittle than (*a*), but of dazzling whiteness and more lustrous.

(*c*) Lehner dissolves nitro-cellulose in methylic alcohol ether or sulphethylic acid, adding natural silk waste dissolved in glacial acetic acid, coagulates with a mixture of turpentine oil, chloroform and oil of juniper, and impregnates with fire-proof salt, e. g., sodium acetate.—Bayerisches Industrie- und Gewerbeblatt.

SELECTED FORMULÆ.

A New Bronze.—M. P. E. Secretan, of Paris, has invented and patented a bronze consisting of from 90 to 93 per cent. of copper, from 3 to 7 per cent. of manganese, and from ½ to 3 per cent. of aluminum and nickel. The manganese gives hardness and resistance and the nickel maintains the ductility. The alloy is practically inoxidizable.

Composition for Giving a Polish to Linen.—Herr L. V. Gussone, of Dusseldorf, Germany, has patented a linen polish prepared as follows: A mixture of white wax and carbonate of potash is agitated with hot water, an alcoholic solution of white tallow soap is added, and the whole is then boiled. The composition is applied to the linen with a sponge during the process of ironing.

Composition for Steam Pipe Jackets.—Mr. C. Hardy, of Barnsley, England, has invented a composition non-conductive of heat, consisting of two and a half parts of disintegrated sandstone, three parts of potter's clay, and one part and a half of blue clay. To this mixture is added some porous material, such as cotton or linen, and, in certain cases, a small proportion of tar and ammonia. These materials are intimately incorporated in such a way as to form a paste, which may be applied with a trowel to the steam pipe or other object to be protected.

Plating Small Metallic Objects Without the Use of Electricity.—A process for plating small metallic objects has recently been patented by M. A. Darby, of Paris. It consists in placing the objects to be plated in contact with aluminum or magnesium in a bath of the metal to be deposited, say (1) a solution of a double chloride of ammonium and of the said metal, to which is added an excess of an alkaline phosphate, or (2) a solution of a double cyanide of potassium and of the metal, to which is added an alkali. By this process, it is possible to deposit nickel, cobalt, tin, copper, gold, etc. There is a process known in which zinc is employed as the contact metal, but in this the zinc becomes covered with the metal almost as quickly as the object to be plated, and the progress of the operation is thus impeded.

A New Match.—M. O. Lindner, of Paris, has recently patented a match which may be lighted by friction upon any surface whatever, and which possesses the advantages of being free from danger and of emitting no unpleasant odor. The mixture into which the splints are first dipped consists of—

Chlorate of potash	6 parts.
Sulphide of antimony	2 "
Gum	1½ "
Powdered clay	1½ "

The inflammable compound consists of—

Chlorate of potash	2 to 3 parts.
Amorphous phosphorus	6 "
Gum	1½ "
Aniline	1½ "

Harmless Colors for Confectionery, Cakes, Sirups, Etc.

YELLOW.

Various shades of yellow may be obtained by the maceration of Besiello saffron, or turmeric, or grains d'Avignon in alcohol until a strong tincture is obtained. Dilute with water until desired shade is obtained. An aqueous solution of quercitrin also gives an excellent yellow.

BLUE.

Indigo carmine	1 part.
Water	2 "

Mix.

Indigo carmine is a beautiful, powerful and harmless agent. It may usually be bought commercially, but if you can not readily obtain it, proceed as follows:

Into a capsule put 30 grains of indigo in powder, place in a water bath and heat to dryness. When entirely dry put into a large porcelain mortar (the substance swells enormously under subsequent treatment—hence the necessity for a large, or comparatively large, mortar) and cautiously add, drop by drop, 120 grains by weight of sulphuric acid, C. P., stirring continuously during the addition. Cover the swollen mass closely, and set aside for 24 hours. Now add 3 fluid ounces of distilled water, a few drops at a time, rubbing or stirring continuously. Transfer the liquid thus obtained to a tall, narrow glass cylinder or beaker, cover and let stand for four days, giving the liquid an occasional stirring. Make a strong solution of sodium carbonate or bicarbonate, and at the end of the time named, cautiously neutralize the liquid, adding the carbonate a little at a time, stirring the indigo solution and testing it after each addition, as the least excess of alkali will cause the indigo to separate out, and fall in a doughy mass. Stop when the test shows the near approach of neutrality, as the slight remaining acidity will not affect the taste or the properties of the liquid. Filter, and evaporate in the water bath to dryness. The resultant matter is sulphindigotate of potassium, or the "indigo carmine" of commerce.

Tincture of indigo may be also used as a harmless blue.

GREEN.

The addition of the solution of indigo carmine to an infusion of any of the matters given under "yellow," will produce a green color. Tincture of crocus and glycerin in equal parts, with the addition of indigo carmine solution, also gives a fine green. A solution of commercial chlorophyl gives grass-green, in shades varying according to the concentration of the solution.

Detection of Cottonseed Oil in Lard.—

Make a 2 per cent. solution of silver nitrate in distilled water, and acidify it by adding 1 per cent. of nitrate acid, C. P. Into a test tube put a sample of the suspected lard and heat gently until it liquefies. Now add an equal quantity of the silver nitrate solution, agitate a little and bring to a boil. Continue the boiling vigorously for about eight minutes. If the lard remain clear and colorless, it may be accepted as "straight goods." The presence of cottonseed oil or fat will make itself known by a coloration, varying from yellow, grayish green to brown, according to the amount present.—National Druggist.

NEW METHOD OF DESIGNING FABRICS.

JACQUARD cards, for all kinds of fabrics, form an enlarged image of the model reproduced in a peculiar manner in mosaic. The enlarging is done at present either by hand or by means of photography. This enlarged image upon card paper is divided into a large number of squares, which are afterward covered with an appropriate color in order to differentiate the various parts of the design. The arrangement of these squares by groups, called "draughts" or "cordings," is repeated regularly upon a certain surface of the image. The number of draughts is unlimited.

The contours of the image consist of squares arranged in steps. Only those are put in color of which half at least of the surface belongs to the image. Therefore, all those of which the center is situated outside of the external contours of the image itself are set aside. The ruling adopted according to the different proportions of warp to weft is so varied that there now exist more than three hundred kinds of paper corresponding to all these proportions. The cardboards employed are, in addition, provided with subdivisions called "designs," the object of which is to simplify the reading of the cards.

In order to distinguish the draughts or cordings and the different parts of the image from each other, different colors are given to them. After these few generalities we may state that Herr Jan Szczepanik, of Vienna, has devised a process of designing Jacquard fabrics in which the phenomena of optics and the resources of photography are brought into requisition. This process is based upon the combined action of a diaphragm and a perforated plate upon the light that passes through a photographic objective (Fig. 1).

Let *MM* be the model of which it is desired to obtain

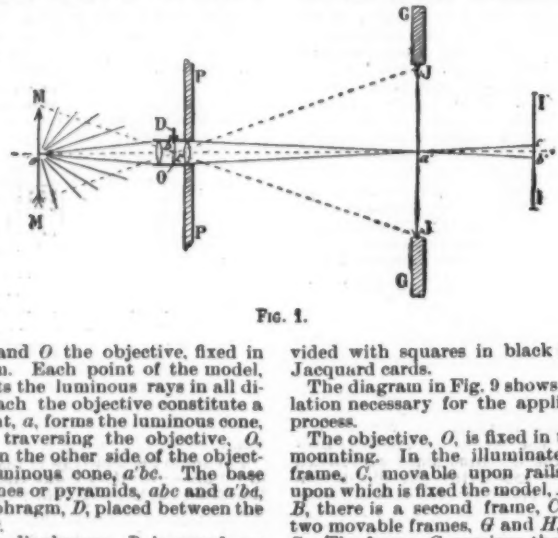

FIG. 1.

a photographic design, and *O* the objective, fixed in wall, *PP*, of a dark room. Each point of the model, *M* (*a* for example), reflects the luminous rays in all directions. Those that reach the objective constitute a luminous cone. The point, *a*, forms the luminous cone, *abc*. These rays, after traversing the objective, *O*, converge at a point, *a'*, on the other side of the objective and form a second luminous cone, *a'bc*. The base in common of the two cones or pyramids, *abc* and *a'bc*, is the opening of the diaphragm, *D*, placed between the lenses of the objective, *O*.

If the aperture in the diaphragm, *D*, is round, we shall have two luminous cones joined by their circular base; if it is trianguar or square (Fig. 2), we shall have

FIG. 2.

FIG. 3.

in the same way two pyramids joined by their triangular or square base (Fig. 3).

Each of the points, *a*, of the model, *M*, therefore gives rise to a corresponding point, *a'*, and all such points, *a'*, as a whole will reproduce upon a plate of ground glass, *GG*, an enlarged and inverted image, *JJ*, of the model, *M*.

But if for the ground glass, *G*, we substitute a plate provided at *a'* with a small aperture, all the luminous rays of the pyramid, *a'bc*, will traverse it and form a new pyramid, *a'b'c'*, like the pyramids, *a'bc* and *abc*. And if the rays be intersected by a plate of ground glass, *II*, the section, *b' c'*, thus obtained, and that constitutes the base of the pyramid, *a'b'c'*, will be like the common base, *bc*, of the two pyramids, *abc* and *a'bc*, that is to say, like the diaphragm, *D*, of the objective, *O*.

The more distant the ground glass is from the perforated plate, *G*, the larger will appear the image of the diaphragm upon the ground glass, *I*; and, if the plate, *G*, is provided with a large number of apertures, we shall see upon the plate, *I*, the same number of images of the diaphragm, *D*, all equal to one another.

The combined action of the diaphragm and perforated plate is utilized by Szczepanik in the following way:

At the place that the model will occupy, is fixed a

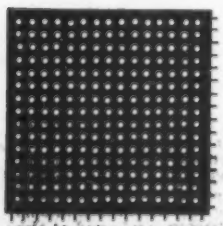

FIG. 4.—Perforated Plate.

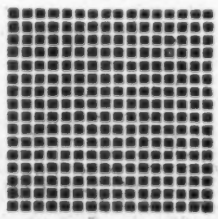

FIG. 5.

sheet of strongly illuminated white paper which is projected upon a plate provided with a large number of apertures (Fig. 4). Behind this plate is arranged a plate of ground glass that may be made to recede from or approach the perforated plate at will.

Consequently, if we place a square diaphragm in the objective, between the lenses, we shall see as many luminous squares appear upon the ground glass as there are apertures in the perforated plate; and if for the ground glass we substitute a sheet of sensitized paper, we shall obtain a negative image such as shown in Fig. 5.

So, too, the diaphragm represented in Fig. 6 will give the image shown in Fig. 7; and if we cause the ground

FIG. 6.

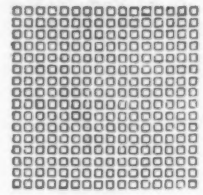

FIG. 7.

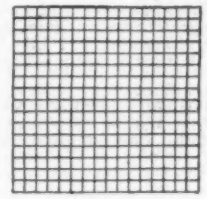

FIG. 8.

glass or sensitized paper to recede, the squares of Fig. 7 will enlarge until they unite and form a checkered surface such as shown in Fig. 8. We can obtain this same Fig. 8, without displacing the ground glass, by substituting a larger diaphragm for the one shown in Fig. 6, at the moment at which it gives the image of Fig. 7.

By substituting a sheet of sensitized paper for the ground glass, and illuminating it for the proper length of time, there may be obtained, after the usual development and fixing, a negative photographic image provided with squares in black (Fig. 8) exactly like the Jacquard cards.

The diagram in Fig. 9 shows the photographic installation necessary for the application of the Szczepanik process.

The objective, *O*, is fixed in the wall, *PP*, in a conical mounting. In the illuminated space, *A*, there is a frame, *C*, movable upon rails and carrying a board upon which is fixed the model, *M M*. In the dark room, *B*, there is a second frame, *C'*, upon rails supporting two movable frames, *G* and *H*, connected by a bellows, *S*. The frame, *G*, receives the perforated plate, *J*, the

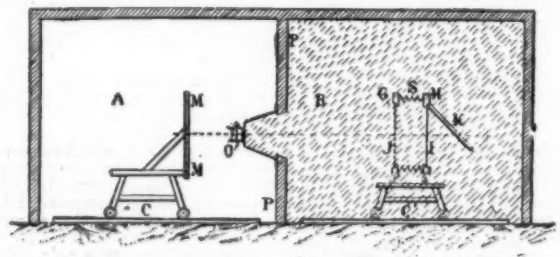

FIG. 9.—Photographic Arrangement for the Szczepanik Process.

frame, *H*, the ground glass, *I*, or the sensitized paper held by the cover, *K*.

By modifying the distance of the frames, *C* and *C'*, from the objective, *O*, it is possible to obtain a more or less reduced or enlarged image of the model, *M*. Different arrangements permit of rapidly and accurately placing the frames, *CC'*, in such a position that the image of the model shall fall upon a determinate number of apertures in the plate, *J*. By examining the ground glass, *I*, it may be seen whether or not the desired result has been obtained.

If the objective is provided with a square diaphragm (Fig. 2), the model (Fig. 10) fixed upon the frame at *M*,

FIG. 10.—Model.

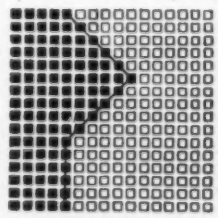

FIG. 11.

will give an image formed of squares (Fig. 11). The limits or contours of the model will appear in the form of entire squares. In fact, there can appear upon the contour only those of the squares of which the corresponding aperture in the perforated plate has been illuminated. Now, each of these apertures corresponds to the center of a square. Squares, therefore, will be observed to appear upon the contour only where the contour of the image projected meets the apertures of the perforated plate, that is to say, the center of the squares.

The result obtained will be exactly the same as in ordinary designing done by hand.

Let us suppose, now, that we desire to design the model represented in Fig. 12 in such a way as to obtain the ground in a satin of eight knots of warp and the design in a satin of five knots of weft. For the entire card, it will require two draughts. These can be obtained by photography separately only. It will, therefore, be necessary to photograph the model twice, once for each draught or cording; and in order, for example, to obtain the ground with its cording, it will be necessary, by some means or other, to conceal the design itself, so as to photograph the ground only. The cording is obtained by means of a special perforated plate. Fig. 13 shows one of these cording plates. Upon this plate, the centers of the apertures occupy exactly the same position upon the perforated plate that we have considered up to the present, but the apertures corresponding to the satin of eight knots of warp have alone been pierced. These apertures, moreover, are larger than those of the primitive perforated plate.

The design of the model having been concealed,

FIG. 12.—Model.

this cording plate is placed against the perforated plate, on the side toward the objective, in such a way as to make the centers of all the corresponding apertures coincide.

The sensitized paper being in place, the objective is uncovered, and in a few minutes the bottom of the model will be photographed along with the cording to which corresponds the cording plate employed.

The objective is then covered, and the cording plate is changed. In the present case, it is replaced by that of the satin of five knots of weft (Fig. 14). The bottom of the model is concealed so as to allow the design alone to appear, and the latter is then photographed with its cording. The model is afterward removed and replaced

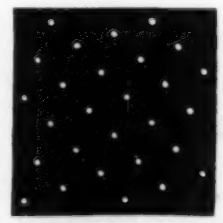

FIG. 13.—Draught Plate for Satin of Eight Knots of Warp.

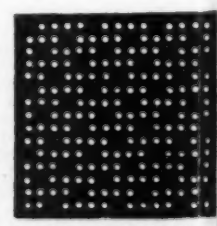

FIG. 14.—Draught Plate for Satin of Five Knots of Weft.

In this way, with the diaphragm shown in Fig. 16 and the plate in Fig. 15, are obtained the vertical stripes represented in Fig. 17, and with the diaphragm of Fig. 19 and the plate of Fig. 18 the horizontal stripes shown in Fig. 20.

In receiving these two stripes successively upon the same sheet of sensitized paper, we shall obtain the horizontal and vertical stripes shown in Fig. 21. We might, moreover, obtain them simultaneously by using the diaphragm shown in Fig. 22 and the plate represented in Fig. 23.

The cards thus obtained are of a single color only, the black of the photographic paper. The majority of the cards made by hand, however, are painted in several colors, in order that each of the parts of the model and the different cordings may be distinguished from each other.

In the Szczepanik process the colors are replaced by

FIG. 15.

FIG. 16.

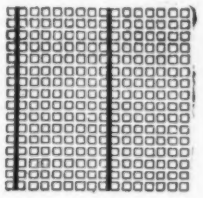

FIG. 17.

various signs produced by means of different diaphragms. Every time that another part of the model or another cording plate is photographed, another diaphragm has to be employed. If two or more cording plates coincide in the same square, there can be no confusion, because the signs given by these diaphragms are so chosen that two, and even three of such signs, reproduced in the same square, may be distinguished from each other, as may be seen, for example, in the diaphragms shown in Figs. 24, 25, and 26.

It will be possible, moreover, by means of diaphragms, to photograph figures (Figs. 27, 28, and 29) instead of signs, and to employ them in such a way that these shall indicate the order to be followed in the reading of the design. In this manner, in the reading, the lifter will know, for example, whether he should pierce the figure 1 in each row of squares, and then, for the second card, the figure 2, etc.

It is thus possible by optical means to divide each square or rectangle of the card into two parts in the direction of the height, by means of the diaphragms

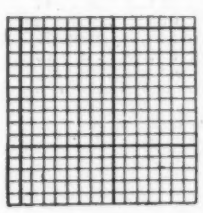

FIG. 21.

FIG. 22.

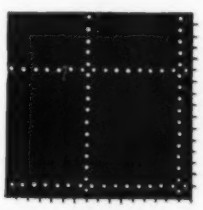

FIG. 23.

represented in Figs. 30, 31, and 32. For the cordings of the first shuttle-stroke, the diaphragm shown in Fig. 30 is used; for the second card, that shown in Fig. 31. The diaphragm of Fig. 32 makes the cordings for the two rows simultaneously.

Figs. 33, 34, and 35 represent the negatives obtained by photographing a sheet of white paper when the diaphragms of Figs. 30, 31, and 32 have been employed with the interposition of a perforated plate.

In like manner, three divisions for each square or rectangle upon the card would be obtained by employing diaphragms carrying three divisions, instead of two as in the preceding ones.

For designing, there exist several hundred draughts and cordings, which may be divided into three categories, simple, reinforced, and mixed. The two last are derived from the first.

FIG. 24.

FIG. 25.

FIG. 26.

FIG. 27.

FIG. 28.

FIG. 29.

FIG. 30.

FIG. 31.

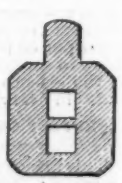

FIG. 32.

For designing by the Szczepanik process, it suffices to possess cordings of the first category upon cording plates. Upon causing one of these plates to slide horizontally or vertically upon the perforated plate, or else in photographing two or three cordings upon the same sheet, or in employing simultaneously two cording plates, we shall obtain thousands of combinations, always representing new draughts or cordings. In order to simplify the shifting of the cording plate of one or more rows, the apparatus is provided with a special arrangement that permits of moving it upon the perforated plate in acting simply upon a winch.

In many cases, for fabrics of several warps and several wefts, the cards are designed by hand, in such a way as to take a separate row of squares for each warp or each thread of the weft. In case, of course, each special cording presents itself in a different form for each way.

It is possible in the same manner to obtain such cordings either by means of appropriate cording plates or of several ordinary plates, but, in the latter case, in making use of appropriate diaphragms that divide the square into four parts:

Diaphragm 37 serves for the cording required by the first warp and first weft.

Diaphragm 38 serves for the cording required by the first warp and second weft.

Diaphragm 39 serves for the cording required by the second warp and first weft.

Diaphragm 40 serves for the cording required by the second warp and second weft.

Finally, the convenience of these rapidly performed operations may permit of the introduction into the designing, and into fabrics, of a larger number of cordings, which, properly chosen and combined, may, in many cases, produce in a fabric certain effects of light and shade that will increase its artistic perfection.

Upon employing perforated plates, as we have already seen, it is possible to establish models only in the invariable ratio of 1 : 1 : 8 : 8 : 10 : 10; etc.

The designings for fabrics necessitating more threads upon the weft than upon the warp, or inversely, may also be obtained by means of these same perforated plates. It suffices, without modifying the division in squares, or replacing the latter by rectangles, to reduce or enlarge by photography the design furnished by the manufacturer, in the direction of its width or length, without modifying its second dimension, in such a way that the image obtained shall occupy (in length, for example) the number of squares desired for representing a determinate number of weft threads. Such a result is obtained in a very simple manner by means of the specially constructed cylindrical lenses of an objective that correspond to the different ratios sought. So that, if it be desired, for example, to obtain a circle in a fabric of which the weft is stronger than the warp, the circle drawn upon the model is, through an appropriate combination of the objective, photographed in such a way as to obtain a distorted image of it in the desired proportions and in a single direction, that is to say, an ellipse. The designing will be done as if we were operating for a ratio of 8 : 8, for example, by means of the same plates; and, since the weft is stronger than the warp, we shall obtain the desired circle in the fabric upon weaving anew.

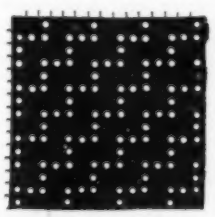

FIG. 36.—Draught Plate for Taffeta of Double Weft.

Since the image is thus capable of being reduced or enlarged at pleasure, we shall be able to select any ratio whatever between warp and weft, without depending, as up to the present, upon types of paper that are found in the market and that do not always exactly answer requirements.

The perforated plates used in the process just described were at the outset very difficult to manufacture, especially because of the great accuracy with which the apertures had to be formed. Each plate, in fact, contains about from 800 to 1,200 small apertures, according to the number of the weft or warp threads of the fabric, and these apertures are from 0·04 to 0·06 of an inch apart. They are now prepared upon glass or upon special films and are reproduced by the lithographic process or by means of other special arrangements.

This new process, in employing photography for the designing of a model for Jacquard fabrics, permits of performing this operation with strict accuracy and very great rapidity and quite cheaply.

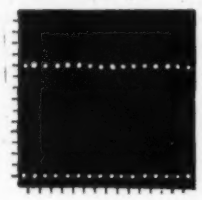

FIG. 18.

FIG. 19.

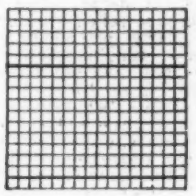

FIG. 20.

For the above particulars and the engravings we are indebted to Le Génie Civil.

[Continued from SUPPLEMENT, No. 1250, page 20040.]

VARIATION AND SOME PHENOMENA CONNECTED WITH REPRODUCTION AND SEX.*

ACQUIRED CHARACTERS.

WE now come to the consideration of the second kind of variations — namely, those which owe their origin to the direct action of external agencies upon the particular organism which shows the variation; or, as Darwin puts it, to the definite action of external conditions. These are the variations which I have called acquired variations or acquired characters. This is not a good name for them, but at the present moment, when I am about to submit them to a critical examination, I do not know of any other which could be suitably applied. Later on, when I sum up the various effects of the direct action of external agencies upon the organism, I may be able to use a more suitable term.

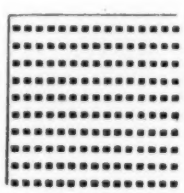

FIG. 33.

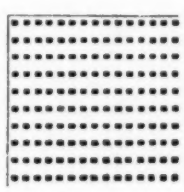

FIG. 34.

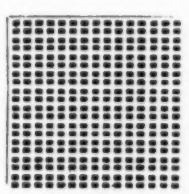

FIG. 35.

The main peculiarities of acquired variations are two in number: (*a*) they make their appearance as soon as the organism is submitted to the changed conditions; (*b*) speaking generally, they are more or less the same in all the individuals of the species acted upon. As examples of this kind of variations, I may mention the effect of the sun upon the skin of the white man; the Porto Santo rabbit, an individual of which recovered the proper color of its fur in four years under the English climate;† the change of Artemia salina to Artemia milhausenii; the increase in size of muscles as the result of exercise; and the development of any special facility in the central nervous system. Among plants, variations of this kind are very easily acquired, by altering the soil and climate to which the individuals are submitted. So common are they, that it is quite possible that a large number of species are really based upon characters of this kind; characters which are produced solely by the external conditions, and which frequently disappear when the old conditions are reverted to.

With regard to these variations, we want to ask the following question: Do they ever last after the producing cause of them is removed, and are they transmitted in reproduction? In a great number of cases they either cease when the cause which has produced them is removed, or if they last the life of the individual, they are not transmitted in reproduction. But is this always the case? That is the important question we now have to consider.

But before doing so, let us inquire what acquired characters really are. The so-called adults of all animals have, as part of their birthright, a certain plasticity in their capacity of reacting to external influences; they all have a certain power of acquiring bodily and mental characters under the influence of appropriate stimuli. This power varies in degree and in quality in different species. In plants, for instance, it is mainly displayed in habit of growth, form of foliage, etc.; in man, in mental acquirements, and so on.

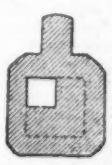

FIG. 37.

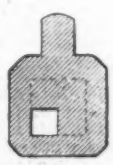

FIG. 38.

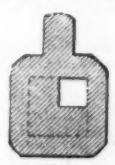

FIG. 39.

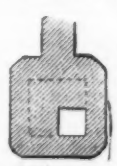

FIG. 40.

But, however it is displayed, it is this property of organisms which permits of the acquisition of those modifications of structure which have been so widely discussed as acquired characters. Now this power, when closely considered, is in reality only a portion of that capacity for development which all organisms possess, and with which they become endowed at the act of conjugation. A newly formed zygote possesses a certain number of hidden properties which are not able to manifest themselves unless it is submitted to

* Opening address by Adam Sedgwick, M.A., F.R.S., President of the Zoological Section, British Association.

† Darwin, "Variation," ed. 2, vol. i., p. 119.

certain external stimuli. It is these stimuli which constitute the external conditions of existence, and the properties of the organism which are only displayed under their influence are what we call acquired characters. They are acquired in response to the external stimuli.

It would appear, then, that every feature which successively appears in an organism in the march from the uninucleated zygote to death is an acquired character. At first the stimuli which are necessary are quite simple, being little more than appropriate heat and moisture; later on they become more complicated, until finally, when the developmental period is over and the mature life begins, the necessary conditions attain their greatest complexity, and their fulfillment constitutes what we call in the higher animals education. Education is nothing more than the response of the nearly mature organism to external stimuli, the penultimate response of the zygote to external stimuli, the ultimate being those of senile decay, which end in natural death. Acquired properties, it will be seen, are really stages in the developmental history. They differ in the complexity of the stimulus required to bring them out. For instance, the segmentation of the egg requires little more than heat and moisture, the walking of the chick the stimulus of light, sound, and gravity, the evolutions of an acrobat the same in greater complexity, and lastly the action of a statesman requires the stimulation of almost every sense in the greatest complexity. Moreover, not only are there differences in the complexity of the stimulus required, but also in the rapidity with which the organism reacts to it. The chick undergoes its whole embryonic development in three weeks, a man in nine months; the chick develops its walking mechanism in a few minutes, while a man requires twelve months or more to effect the same end. Chickens are much cleverer than human beings in this respect. There is the same kind of difference between them that there is between the power of learning displayed by a Macaulay and that displayed by a stupid child

An instinct is nothing more than an internal mechanism which is developed with great rapidity in response to an appropriate stimulus. It is difficult for us to understand instincts, because with us almost all developmental processes are extremely slow and gradual. This particularly applies to the development of those nervous mechanisms, the working of which we call reason.

Within certain limits the external conditions may vary without harming the organism, but such variations are generally accompanied by variations in the form in which the properties of the zygote are displayed. If the variations of the conditions are too great, their action upon the organism is injurious and results in abortions or death. And in no case can the external conditions call out properties with which the zygote was not endowed at the act of conjugation.

It would thus appear that acquired characters are merely phases of development; they are the manifestations of the properties of the zygote, and are called forth only, under appropriate stimulation; moreover, they are capable of varying within certain limits, according to the nature of the stimulus, and it is to these variations that the term acquired character has been ordinarily applied.

A genetic character, on the other hand, is the possibility of acquiring a certain feature under the influence of a certain stimulus; it is not the feature itself—that is an acquired character—but it is the possibility of producing the feature. Now as the possibility of producing the feature can only be proved to exist by actually producing it, the term genetic character is frequently applied to the feature itself, which is, as we have seen, an acquired character. In consequence of this fact, that we can only determine genetic characters by examining acquired characters, a certain amount of confusion may easily arise, and has indeed often arisen, in dealing with this subject. This can be avoided by remembering that in describing genetic characters account must always be taken of the conditions. For example, the white fur of the Arctic hare is an acquired character, acquired in response to a certain stimulus; while the power of so responding to the particular stimulus when applied at the correct time in a genetic character. Thus a genetic character is a character which depends upon the nature of the organism, while an acquired character depends on the nature of the stimulus.

If we imagine a zygote to be a machine capable of working out certain results on material supplied to it, then we should properly apply the term genetic character to the features of the machinery itself, and the words acquired character to the results achieved by its working. These clearly will depend primarily on the structure of the machinery, and secondarily upon the material and energy supplied to it—that is to say, upon the way in which it is worked.

Variations in genetic characters are variations in the machinery of different zygotes—that is to say, in the constitution—while variations in acquired characters are variations in the results of the working of one zygote according to the conditions under which it is worked.

For instance, let us take the case of those twins which arise by the division of one zygote, and are consequently identical in genetic characters, i. e., in constitution. If they are submitted to different conditions they will develop differences which will depend entirely upon the conditions and the time of life when the differentiation in the conditions occurred. These differences, then, will be a function of the external conditions, i. e. of the manner in which the machinery is worked, and constitute what we call variation in acquired characters.

ARE ACQUIRED CHARACTERS TRANSMISSIBLE AS SUCH IN REPRODUCTION?

To return to our question, are the so-called acquired characters ever transmitted in reproduction? Let us consider what this question means in the light of the preceding discussion. Acquired characters are features which arise in the zygote in response to external stimuli. Now the zygote at its first establishment has none of the characters which are subsequently acquired. All it has is the power of acquiring them. Clearly, then, acquired characters are not transmitted. The power of producing them is all that can be transmitted; and this power resides in the reproductive organs and in the gametes to which the reproductive organs give rise, so that the question must be put in another form. Is it possible by submitting an organism to a certain set of conditions, and thus causing it to acquire certain characters, so to modify its reproductive organs that the same characters will appear in its offspring as the result of the application of a different and simpler stimulus?

For instance, the power of reading conferred by education, the hardness of the hands and increased size of the muscles produced by manual labor: is it possible that these characters, now produced by complex external stimuli applied at a particular period of life, should ever in future ages be produced by the simpler stimuli found within the uterus, so that a man may be born able to read or write, or with hands horny and hard like those of a navvy?

In trying to find an answer to this question, let us first of all look into the probabilities of the case, to see if we can relate the question to any other class of phenomena about which we have, or think we have, definite knowledge.

When an organism is affected by external agents, the action may apply to the whole organization or principally to one organ. Let us take a case in which one organ only appears to be affected, e. g., the enlargement by exercise of the right arm of a man. Now, although in this case it is only the muscles of the arm which appear at first sight to be affected, we must not forget that the organs of the body are correlated with one another and an alteration of one will produce an alteration in others. By exercise of the right arm the muscles of that arm are obviously enlarged, but other changes not so obvious must also have taken place. The bones to which the muscles are attached will be altered; the blood-vessels supplying the muscles will be enlarged, and the nerves which act upon the muscles, and probably the part of the central nervous system from which they proceed, will also be altered. These are some of the more obvious correlated changes which will have occurred: no doubt there will have been others—indeed, it is not perhaps too much to say that all the organs of the body will have reacted to the enlargement of the arm—but the effect on organs not in functional correlation with the muscles of the right arm will be imperceptible, and may be neglected. Thus the color of the hair, the length and character of the alimentary canal, size of the leg muscles, the renal organs, etc., will not show appreciable alteration. Above all, the other arm will not be affected, or if it is affected, the alteration will be so slight as not to be noticeable. Now, we know that homologous parts, whether symmetrically homologous or serially so, are in some kind of close connection. For instance, when one member of an homologous series varies, it is commonly found that other members of the same series will also vary. Yet in spite of this connection which exists between the right and left arms and between the right arm and right leg, there is no similar alteration either in the left arm or in the right leg. Now, if parts which from these facts we may suppose to be in some connection are not affected, how can we expect the reproductive organs not only to be modified, but also to be modified so that the germs which are about to be budded off from them will be so affected as to produce exactly the same character—in this case enlarged muscle, etc.—without the application of the same stimulus, viz., exercise? Thus, while I freely admit that every alteration of an organ in response to external agents will react through the whole organization, affecting each organ in functional correlation with the affected organ in a way which will depend upon the function of the correlated organ, and possibly other organs not in functional correlation in an indefinite way and to a slight extent, yet I maintain that it is very hard to believe that it will have such a sharp and precise effect upon every spermatozoon and ovum subsequently produced that not merely will these products be altered generally in all their properties, but that one particular part of them—and that part of them always the same—will be so altered that the organisms which develop from them will be able to present the same modification on the application of a different stimulus. It is inconceivable; unless indeed we suppose that the very molecules of the incipient organs in the germ are more closely correlated with corresponding parts of the parent body than are the homologous parts of the parent body with one another.

Now, to prove the existence of such a remarkable and intimate correlation would surely require the very strongest and most conclusive evidence. Is there any such strong evidence? I think I may fairly answer this question in the negative. The evidence which has been brought forward in favor of the so-called inheritance of acquired characters is far from conclusive. That such evidence * exists I do not deny, but it is all, or almost all, capable of receiving other interpretations.

EFFECT OF CHANGED CONDITIONS UPON THE REPRODUCTIVE ORGANS.

On the other hand, all the certain evidence we have concerning what happens when the reproductive organs are affected, either directly or by correlation, by a change of conditions—and, as we have seen above, they must be affected if there is to be any change in the offspring—tends to show that there is not any relation between the effect produced on the parent and that appearing in the offspring.

The only means of judging whether the reproductive organs are affected by external conditions is by observing any change which may occur in their function. Now, only two such physiological effects of a change of conditions are certainly known; these are (1) the production of sterility or of partial sterility; (2) the production of an increased but indefinite variability in the offspring. With regard to the first of these effects: One of the most common, or at any rate one of the most noticeable, alterations in an organism effected by change in the external conditions is an alteration of the reproductive system, an alteration of such a kind that organisms which had previously freely interbred with one another are no longer able to do so. One of the most common results of removing organisms from their natural surroundings is to induce sterility or partial sterility. There is no reason to doubt that this sterility or tendency to sterility is, broadly speaking, due to an affection of the reproductive system. In the case of the higher animals, it may in some cases be due to an action upon the instincts, but in the lower animals and in plants we can hardly doubt that it is due to a direct action upon the reproductive organs. Indeed, in plants these organs are often visibly affected. Among animals, however, there does not appear to be any satisfactory evidence on the point, and it is not known what organs are affected, whether it is the actual gametes, or the reproductive glands, or some of the other organs concerned.*

The other result of changed conditions which is certainly known is to induce an increased amount of variability of the genetic kind, though not immediately, often indeed not until after the lapse of some generations. On this point Darwin says: "Universal experience shows us that when new flowers are first introduced into our gardens they do not vary; but ultimately all, with the rarest exceptions, vary to a greater or less extent" ("Variation," 2, p. 249).† With regard to the variability thus induced, it is to be noticed that it is not confined to any particular organ, nor does it show itself in any particular way. On the contrary, the whole organization is affected, and the variations are quite indefinite.

To sum up the argument as it at present stands: (1) a change in conditions cannot affect the next generation unless the reproductive organs are affected; (2) from a consideration of the facts of the case, it is almost inconceivable that the effect produced upon any organ of a given organism by a change of conditions should so modify the reproductive organs of that organism as to lead to a corresponding modification in the offspring without the latter being exposed to the same conditions; (3) the only effects, which are certainly known, of changed conditions upon the reproductive organs are (*a*) the production of sterility; (*b*) an increase in genetic variability.

As far, then, as our certain knowledge goes, it would appear that a change of conditions may have one or both of the following effects:

(1) A definite change, of the same character, or nearly so, in all the individuals acted upon. Such changes may be adaptive or non-adaptive, but they are not permanent, lasting only so long as the change of conditions, or at most during the life of the individual acted upon. They are not transmitted in reproduction, and do not appear in the offspring unless it is submitted to the same conditions. These variations are the direct result of the action of the environment upon the individual, with the exception of the reproductive organs.

(2) Increase in the variations of the genetic kind. These are seen, not in the generation ‡ first submitted to the changed condition, but in the next or some subsequent generations. The effect is produced through the reproductive organs. These variations are non-adaptive, and different in each individual.

If the reproductive organs are affected, we get an increase in the variations of the genetic kind. These, we have seen, are usually of an indefinite character; they are different in every case, and their nature cannot be predicted from experience. But we still have to ask: If this is a universal rule? Does it never happen that a change of conditions so affects the reproductive organs as to produce a definite non-adaptive change of the same character or nearly so in all the descendants of the individual acted upon? This is the most obscure question connected with the study of variations. If such changes occur, they might be cumulative, being increased in amount by the continued action of the conditions. They would be non-adaptive, their nature depending on the constitution of the reproductive cells and having no functional relation to the original stimulus.

As possible examples of such variation, I may recall those variations referred to by Darwin as "fluctuating variations which sooner or later become constant through the nature of the organism and of surrounding conditions, but not through natural selection" ("Origin," ed. 6, p. 176); to the variations in turkeys and ducks which take place as the result of domestication ("Variation," 2, p. 250); to those variations which Darwin had in his mind when he wrote the following sentence ("Origin," p. 72): "There can be little doubt that the tendency to vary in the same manner has often been so strong that all the individuals of the same species have been similarly modified without the aid of selection."

It is, however, as I have said, extremely doubtful if variations of this kind really occur. The appearance of them may be caused by the combination of the two other kinds of variation. In all cases which might be cited in support of their occurrence, there are the following doubtful elements: (1) no clear statement as to whether the variations showed themselves in the individuals first acted upon; (2) no history of the organisms when transported back to the old conditions.

Moreover, a general consideration of the facts of the case renders it improbable that such similar and definite genetic variations should often occur at any rate in sexual reproduction. For although the effect upon the reproductive organs may possibly be almost the same in nearly all the individuals acted upon, it must not be forgotten that the reproductive elements have to combine in the act of conjugation, and that it is the essence of this act to produce products which differ in every case.

EFFECT OF CHANGED CONDITIONS IN ASEXUAL REPRODUCTION.

This brings us to the consideration of the question reserved: Are genetic variations ever found in asexual reproduction?

If the views expressed in the earlier part of this address are correct, it would seem to follow that genetic variations are variations in the actual constitution, and are inseparably connected with the act of conjugation. The act of conjugation gives us a new com-

* For a good statement and discussion of the evidence in favor of this view, see Romanes' "Darwin and after Darwin," vol. ii., chaps. 3 and 4.

* The exact cause of this sterility in the higher animals is a point which specially needs investigation.

† The phenomenon of increased variability following upon change of conditions has most often been observed when the change has been from a state of nature to a state of cultivation. Hence the conclusion has been drawn that the kind of change involved in domestication alone induces variation. But there is no evidence in favor of this view. The evidence shows that change of conditions in itself may induce greater variability.

‡ No doubt the individuals of the generation first submitted to the changed conditions would be affected as regards their reproductive organs, which would be altered in structure, but this has not been made out, though there are indications of such an effect in certain plants; vide Appendix.

stitution, a new individuality, and it is the characters of this new individual in so far as they differ from the characters of the parents which constitute what we have called genetic variations. According to this, the answer to our question would be that genetic variations cannot occur in asexual reproduction, and that if any indefinite variability recalling genetic variability makes its appearance,* it must be part of the genetic variability and directly traceable to the zygote from which the asexual generations started.

But if genetic variability is not found in asexual reproduction, the question still remains, Can the other kind of variations—namely, those due to the direct action of external forces upon the organism—be transmitted in asexual reproduction? Now we have already seen that the effect of external agencies acting upon the organism must be regarded under two heads, according as to whether the reproductive organs are or are not affected. If the reproductive organs are not affected, then variations caused by the impact of external forces will not be transmitted; if, on the other hand, they are affected, the next generation will show the effect. We have further seen that in the case of sexual reproduction a modification of the reproductive organs will, because of the intervention of conjugation, appear as an increase in genetic variability only. How will the matter stand in the case of asexual reproduction? First, with regard to modifications which do not affect the reproductive system—they, as in sexual reproduction, will not be transmitted. Secondly, as regards modifications which do affect the reproductive organs—they will be transmitted, i. e., they will affect the next generation; and the question arises, How will they be transmitted? For here we have the opportunity wanting in the case of sexual reproduction of studying the transmission of modifications of the reproductive system without the complications introduced by the act of conjugation.

In considering this matter, it must be remembered that the reproductive organs are, with regard to external influences, exactly as any other organ. They can be modified either directly or indirectly, though they are in animals often less liable to direct modification by reason of their internal position.† These modifications may, as in the case of other organs, be obvious to the eye of the observer, or they may be so slight as only to be detected by an alteration of function. Now, in the case of the reproductive organs this alteration of function will show itself in the individuals of the next generation (if not before) which proceed directly and without any complication from the affected tissue. How will these individuals be affected? Will they all be affected in the same kind of way, or will they be affected in different ways? Finally, will the modification last their lives only, or will it continue into subsequent asexually produced generations?

Let us endeavor to answer these questions:

(1) How will the offspring be affected? That will depend entirely upon how the reproductive organ was affected. Will the modification in the offspring have an adaptive relation whatever to the external cause? Now here we have a capital opportunity, an opportunity not afforded at all by sexual reproduction, of examining by experiment and observation the Lamarckian position. My own opinion is that there will be no relation of an adaptive kind between the external cause and the modification of the offspring. For instance, let us imagine, as an experiment, that a number of parthenogenetically reproducing organisms are submitted to a temperature lower than that at which they are accustomed to live. Let us suppose that the cold affects their reproductive organs and produces a modification of the offspring. Will the modification be in the direction of enabling the offspring to flourish in a lower temperature than the parent? My own opinion, as I have said, is that there will probably be no such tendency in the offspring, if all possibility of selection be excluded. But that is only an opinion. The question is unsettled, and must remain unsettled until it is tested upon asexually reproducing organisms.

(2) Will they all be affected in the same kind of way? Yes, presumably they will. I arrive at this conclusion, not by experiment, but by reasoning from analogy. In the case of other organs of the body, the same external cause produces in all individuals acted upon, roughly speaking, the same kind of effect, e. g., action of sun upon skin, effect of transplanting maize, Porto Santo rabbits, etc. The question, however, cannot be settled in this way. It requires an experimental answer.

(3) Will the modification last beyond the life of the individuals produced by the affected reproductive organ? I can give no answer to this question. We have no data upon which to form a judgment. We cannot say whether it is possible permanently to modify the constitution of an organism in this way, or whether, however strong the cause may be, consistently of course with the non-destruction of life, the effects will gradually die away—it may be in one, it may be in two or more generations. There are cases known which might assist in settling these questions, but I must leave to another opportunity the task of examining them. I refer to such cases as Artemia salina, various cases of bud variation which cannot be included under the head of growth variation.

(To be continued.)

The manufacture of flags of various kinds has become a great industry in the United States, owing to the fact that in no country in the world are flags hung out more universally on occasions of public interest. There are thirty flag factories in the United States, with an invested capital of $500,000 and paying in wages nearly $200,000 a year. Many other flags than those used for patriotic decoration or display are made in this country. There are the railroad flags, of which enormous numbers are in use. These signal flags come in two sizes, 20 × 18 inches and 24 × 18 inches. There are, it is said, more red than green signal flags and more green than white. Other cheap flags in general use are for yachts, for use by contractors and railroad builders, for steamships and auctioneers, and for social societies. The United States having a great cosmopolitan population, especially in the large cities, it is no unusual thing in times of celebration or festivity to see flags of foreign countries displayed—foreign flags of American make. There are, for instance, more Irish flags with the gold harp on the green background made in the United States than in any other country, and for many years all the Cuban flags in use by the struggling patriots of that island have been made for them in the United States.—American Exporter.

[Continued from SUPPLEMENT, No. 1250, page 20046.]

GEOGRAPHY.

OPENING ADDRESS BY SIR JOHN MURRAY, K.C.B., F.R.S., LL.D., PRESIDENT OF THE SECTION OF GEOGRAPHY OF THE BRITISH ASSOCIATION.

WHERE the lighter and more bulky substances have accumulated there has been a relative increase of volume, and in consequence bulging has taken place at the surface over the continental areas. Where the denser materials have been laid down there has been flattening, and in consequence a depression of the abysmal regions of the ocean basins. It is known that, as a general rule, where large masses of sediment have been deposited, their deposition has been accompanied by a depression of the area. On the other hand, where broad mountain platforms have been subjected to extensive erosion, the loss of altitude by denundation has been made good by a rise of the platform. This points to a movement of matter onto the continental areas.

If this be anything like a true conception of the interactions that are taking place between the various geospheres of which our globe is made up, then we can understand why, in the gradual evolution of the surface features, the average level of the continental plains now stands permanently about 3 miles above the average level of those plains which form the floor of the deep ocean basins. We may also understand how the defect of mass under continents and an excess of mass under the oceans have been brought about, as well as deficiency of mass under mountains and excess of mass under plains. Even the local anomalies indicated by the plumb-line, gravity, and magnetic observations may in this way receive a rational explanation. It has been urged that an enormous time—greater even than what is demanded by Darwin—would be necessary for an evolution of the existing surface features on these lines. I do not think so. Indeed, in all that relates to geological time I agree, generally speaking, with the physicists rather than with the biologists and geologists.

PROGRESS OF OCEANIC RESEARCH.

I have now touched on some of the problems and speculations suggested by recent deep sea explorations; and there are many others, equally attractive, to which no reference has been made. It is abundantly evident that, for the satisfactory explanation of many marine phenomena, further observations and explorations are necessary. Happily there is no sign that the interest in oceanographical work has in any way slackened. On the contrary, the number of scientific men and ships engaged in the study of the ocean is rapidly increasing. Among all civilized peoples and in all quarters of the globe the economic importance of many of the problems that await solution is clearly recognized.

We have every reason to be proud of the work continually carried on by the officers and ships attached to the Hydrographic Department of the British navy. They have surveyed coasts in all parts of the world for the purpose of navigation, and within the past few years have greatly enlarged our knowledge of the sea bed and deeper waters over wide stretches of the Pacific and other oceans. The samples of the bottom which are procured, being always carefully preserved by the officers, have enabled very definite notions to be formed as to the geographical and bathymetrical distribution of marine deposits.

The ships belonging to the various British telegraph cable companies have done most excellent work in this as well as in other directions. Even during the present year Mr. R. E. Peake has in the steamship "Britannia" procured 477 deep soundings in the North Atlantic, besides a large collection of deep sea deposits and many deep sea temperature and current observations.

The French have been extending the valuable work of the "Talisman" and "Travailleur," while the Prince of Monaco is at the present moment carrying on his oceanic investigations in the Arctic Seas with a large new yacht elaborately and specially fitted out for such work. The Russians have recently been engaged in the scientific exploration of the Black Sea and the Caspian Sea, and a special ship is now employed in the investigation of the Arctic fisheries of the Murman coast under the direction of Prof. Knipowitsch. Admiral Makaroff has this summer been hammering his way through Arctic ice, and at the same time carrying on a great variety of systematic observations and experiments on board the "Yermak"—the most powerful and most effective instrument of marine research ever constructed. Mr. Alexander Agassiz has this year recommenced his deep sea explorations in the Pacific on board the United States steamer "Albatross." He proposes to cross the Pacific in several directions, and to conduct investigations among the Paumotu and other coral island groups. Prof. Weber is similarly employed on board a Dutch man-of-war in the East Indian Seas. The Deutsche Seewarte at Hamburg, under the direction of Dr. Neumayer, continues its praiseworthy assistance and encouragement to all investigators of the ocean, and this year the important German Deep Sea Expedition, in the steamship "Valdivia," arrived home after most successful oceanographical explorations in the Atlantic, Indian, and Great Southern Oceans.

The "Belgica" has returned to Europe safely with a wealth of geological and biological collections and physical observations, after spending, for the first time on record, a whole winter among the icefields and icebergs of the Antarctic. Mr. Borchgrevink in December last again penetrated to Cape Adare, successfully landed his party at that point and is now wintering on the Antarctic continent. The expeditions of Lieut. Peary, of Prof. Nathorst, of Capt. Sverdrup, and of the Duke of Abruzzi, which are now in progress, may be expected to yield much new information about the condition of the Arctic Ocean. Mr. Wellman has just returned from the north of Franz Josef Land with observations of considerable interest.

Some of the scientific results obtained by the expeditions in the Danish steamer "Ingolf" have lately been published, and these, along with the results of the joint work pursued for many years by the Swedes, Danes, and Norwegians, may ultimately have great economic value from their direct bearing on fishery problems and on weather forecasting over long periods of time.

Largely through the influence of Prof. Otto Pettersson, an International Conference assembled at Stockholm a few months ago, for the purpose of deliberating as to a programme of conjoint scientific work in the North Sea and northern parts of the Atlantic, with special reference to the economic aspect of sea-fisheries. A programme was successfully drawn up, and an organization suggested for carrying it into effect; these proposals are now under the consideration of the several states. The Norwegian government has voted a large sum of money for building a special vessel to conduct marine investigations of the nature recommended by this conference. It is to be hoped the other North Sea powers may soon follow this excellent example.

The various marine stations and laboratories for scientific research in all parts of the world furnish each year much new knowledge concerning the ocean. Among our own people the excellent work carried on by the Marine Biological Association, the Irish Fisheries Department, the Scottish Fishery Board, the Lancashire Fisheries Committee, the Cape and Canadian Fisheries Departments, is well worthy of recognition and continued support. Mr. George Murray, Mr. H. N. Dickson, Prof. Cleve, Prof. Otto Pettersson, Mr. Robert Irvine and others have, with the assistance of the officers of the mercantile marine, accumulated in recent years a vast amount of information regarding the distribution of temperature and salinity, as well as of the planktonic organisms at the surface of the ocean. The papers by Mr. H. C. Russell on the icebergs and currents of the Great Southern Ocean, and by Mr. F. W. Walker on the density of the water in the Southern Hemisphere, show that the Australian Colonies are taking a practical interest in oceanographical problems.

PROPOSED ANTARCTIC EXPLORATIONS.

The great event of the year, from a geographical point of view, is the progress that has been made toward the realization of a scheme for the thorough scientific exploration in the near future of the whole South Polar region. The British and German governments have voted or guaranteed large sums of money to assist in promoting this object, and princely donations have likewise been received from private individuals. In this connection the action of Mr. L. W. Longstaff in making a gift of 25,000*l.*, and of Mr. A. C. Harmsworth in promising 5000*l.*, being beyond all praise.

There is an earnest desire among the scientific men of Britain and Germany that there should be some sort of co-operation with regard to the scientific work of the two expeditions, and that these should both sail in 1901, so that the invaluable gain attaching to simultaneous observations may be secured. Beyond this nothing has, as yet, been definitely settled. The members of the Association will presently have an opportunity of expressing their opinions as to what should be attempted by the British expedition, how the work in connection with it should be arranged; and how the various researches in view can best be carried to a successful issue.

I have long taken a deep interest in Antarctic exploration, because such exploration must necessarily deal largely with oceanographical problems, and also because I have had the privilege of studying the conditions of the ocean within both the Arctic and Antarctic circles. In the year 1886 I published an article on the subject of Antarctic Exploration in the Scottish Geographical Magazine. This article led to an interesting interview, especially when viewed in the light of after events, for, a few weeks after it appeared in type, a young Norwegian walked into the Challenger office in Edinburgh to ask when the proposed expedition would probably start, and if there were any chance of his services being accepted. His name was Nansen.

When at the request of the President I addressed the Royal Geographical Society on the same subject in the year 1893, I made the following statement as to what it seemed to me should be the general character of the proposed exploration: "A dash at the South Pole is not, however, what I advocate, nor do I believe that is what British science at the present time desires. It demands rather a steady, continuous, laborious and systematic exploration of the whole southern region with all the appliances of the modern investigator." At the same time I urged further, that these explorations should be undertaken by the Royal Navy in two ships, and that the work should extend over two winters and three summers.

This scheme must now be abandoned, so far at least as the Royal Navy is concerned, for the government has intimated that it can spare neither ships nor officers, men nor money, for an undertaking of such magnitude. The example of foreign powers—rather than the representations from our own scientific men—appears to have been chiefly instrumental in at last inducing the government to promise a sum of 45,000*l.*, provided that an equal amount be forthcoming from other sources. This resolve throws the responsibility for the financial administration, for the equipment and for the management of this exploration, on the representative scientific societies, which have no organization ready for carrying out important executive work on such an extensive scale. I am doubtful whether this state of matters should be regarded as a sign of increasing lukewarmness on the part of the government

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* Weismann, "On Heredity," vol. ii., English edition, p. 161. Warren E., "Observation on Heredity in Parthenogenesis," Proc. Roy. Soc., 65, 1899, p. 154. These are the only observations I know of on this subject. They tend to show the presence of a slight variability, but they are not entirely satisfactory. In connection with this matter, I may refer to Weismann's view that Cypris reptans, the species upon which his observations were made, reproduces entirely by parthenogenesis, and has lost the power of sexual reproduction. This view is based on the fact that he has bred forty consecutive parthenogenetic generations and has never seen a male. As Weismann bases some important conclusions on this view, with regard to the importance of conjugation in rejuvenescence of organisms, I may point out that the fact that he has bred forty successive generations and has never seen a male cannot be regarded as conclusive evidence that males never appear. We know of many cases in which reproduction can continue for more than forty generations without the intervention of conjugation, e. g., ciliated infusoria, many plants, and of other species of crustacea in which the male is very rare and only appears after long intervals.

† How far the abnormal position of the testes of mammalia may receive its explanation in this connection is a question worthy of consideration.

toward marine research, or should rather be looked on as a most unexpected and welcome recognition of the growing importance of science and scientific men to the affairs of the nation. Let us adopt the latter view, and accept the heavy responsibility attached thereto.

Any one who will take the trouble to read, in the Proceedings of the Royal Society of London, the account of the discussion which recently took place on "The Scientific Advantages of an Antarctic Expedition," will gather some idea of the number and wide range of the subjects which it is urged should be investigated within the Antarctic area; the proposed researches have to do with almost every branch of science. Unless an earnest attempt be made to approach very near to the ideal there sketched out, widespread and lasting disappointment will certainly be felt among the scientific men of this country. The proposed expedition should not be one of adventure. Not a rapid invasion and a sudden retreat, with tales of hardships and risks, but a scientific occupation of the unknown area by observation and experiment should be aimed at these days.

I have all along estimated the cost of a well-equipped Antarctic expedition at about 150,000*l*. I see no reason for changing my views on this point at the present time, nor on the general scope of the work to be undertaken by the proposed expedition, as set forth in the papers I have published on the subject. There is now a sum of at most 90,000*l*. in hand, or in view. If one ship should be specially built for penetrating the icy region, and be sent south with one naturalist on board, then such an expedition may, it will be granted, bring back interesting and important results. But it must be distinctly understood that this is not the kind of exploration scientific men have been urging on the British public for the past fifteen or twenty years. We must, if possible, have two ships, with landing parties for stations on shore, and with a recognized scientific leader and staff on board of each ship. Although we cannot have the Royal Navy, these ships can be most efficiently officered and manned from the mercantile marine. With only one ship many of the proposed observations would have to be cut out of the programme. In anticipation of this being the case, there are at the present moment irreconcilable differences of opinion among those most interested in these explorations as to which sciences must be sacrificed.

The difficulties which at present surround this undertaking are fundamentally those of money. These difficulties would at once disappear, and others would certainly be overcome, should the members of the British Association at this meeting agree to place in the hands of their President a sum of 50,000*l*., so that the total amount available for Antarctic exploration would become something like 150,000*l*. Although there is but one central government, surely there are within the bounds of this great empire two more men like Mr. Longstaff. The government has suddenly placed the burden of upholding the high traditions of Great Britain in marine research and exploration on the shoulders of her scientific men. In their name I appeal to all our well-to-do fellow-countrymen in every walk of life for assistance, so that these new duties may be discharged in a manner worthy of the empire and of the well-earned reputation of British science.

CULTIVATION OF THE PISTACHIO NUT IN THE SOUTH.

THE pistachio nut of commerce—that imported into this country—at least, is not of much consequence, since it is largely the fruit of the lentisc pistachio (Pistachia lentisca), the source of gum mastic (the methods of obtaining which tend to dwarf the fruit); but the genuine pistachio, the fruit of the Pistachia vera (Anacardiaceæ) is quite a different thing. The tree which bears it is a native of Syria, while the other variety, the Pistachia lentisca, is a common one on the northern littoral of the Mediterranean, and especially plentiful in the Greek isle of Scio (Chios).

The nut of the lentisca or mastic pistachio is small, hard, and frequently unpalatable, while that of the true Syrian pistachio is a really delicious nut, of a rich, mild, and smooth flavor, and an agreeable odor. It is highly prized by the Greeks and other people of the Levant, but scarcely known in Western Europe, except to connoisseurs. In America we have never seen one, except in the possession of well-to-do Greeks and Italians, who have imported them for their own consumption.

From the the observations of M. C. Jeans, recently published in the Moniteur des Colonies, who has given the subject a most careful and elaborate study, we learn that the Pistachia vera thrives under conditions which make it certain that its cultivation in Florida and other Gulf States, as well as Southern California, would be successful and most profitable as well.

The decline of the trade in the ordinary Italian and Greek pistachio, some time ago, led to an investigation on the part of the Italian government, the results of which show that by cultivatian and improved methods of treatment, the output of the Euopean nut may be increased at least 1,000 per cent. in that country alone.

"The pistachio," says M. Jeans, "is quite plentiful in our southern regions. To reach full development and bear fruit it requires from six to seven years, under ordinary circumstances, but a deep, strong, calcareous soil, and a good exposure, shortens the time materially. It is, however, occasionally found growing lustily on poor and arid hillsides. While a southern and westerly exposure is most favorable, it, nevertheless, flourishes on even northerly exposures. Under the latter circumstances, however, the nuts, though sometimes well developed, lack delicacy of flavor, and never have the perfume of those grown on generous soil, with a southern exposure."—National Druggist.

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